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The WELDING Journal

The Journal of the American Welding Society

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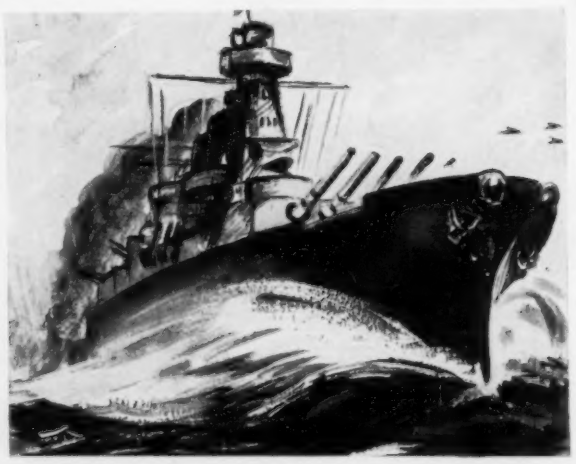

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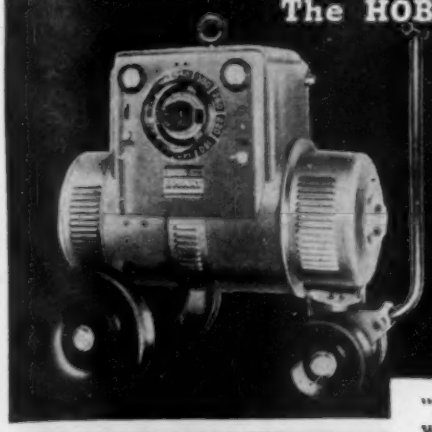

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Published for the Advancement of the Science and Art of Welding

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JUNE 1943

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Group of P-47's in Flight. *Courtesy Republic Aviation Corporation.*

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Deep Fillet Welding Technique and Application*

By M. H. MacKusick, J. B. Hiatt and R. V Anderson†

Preface

HERETOFORE all fillet welding has been based on the supposition that a weld must be built up to required strength by successive layers of weld-metal deposited within the angle formed by the pieces being joined.

Deep penetrating welds wherein the base metal is fused well below the surface of the joint are quite common, especially in the "submerged arc" process commonly known as "Unionmelt" welding. In fact at Calship butt welds in plate up to $^3/_4$ in. thick are made without beveling the edges. The weld is fused at least half the plate thickness from the first side and the process repeated on the second side to obtain complete penetration of the joint. This process requires very much less "filler" metal than for grooved joints since a large portion of the fusion zone is supplied by melting the base metal.

The use of deep penetrating weld for fillets likewise saves on welding rod but the deep penetrating weld will not measure up to specified gage size as determined by all recognized standards of inspection.

One large company has recently published a Bulletin covering the use of penetrating fillet welds and has had their procedure approved by the American Bureau of Shipping. This is the first recognition of deep fillet welding and, as such, is a step in the right direction to conserve welding materials and time at no sacrifice in strength or quality.

The tests outlined in the following report were made for several reasons. First, it was desired to confirm the procedure for our own information and for the benefit of the local inspection services of the American Bureau of Shipping and the Maritime Commission. Second, it was necessary to determine in advance in so far as possible the difficulties to be encountered in actual production. Third, it was hoped that some information might be gained which would result in further improvements.

The results of these tests indicate that the technique outlined in this paper can be successfully applied if the following conditions are met:

1. An adequate supply of A.B.S. approved welding electrode of the AMERICAN WELDING SOCIETY Specification E-6020 or E-6030 must be available.

2. The cooperation of the inspection services of the company, the Maritime Commission and the American Bureau of Shipping must be enlisted in the interpretation of size and strength of fillet welds.

3. Certain problems arising from the technique, particularly the problem of cracking of fillet welds, must be solved. Work is now underway on this problem and it is hoped that an answer can be had by the time conditions are right for the adoption of these procedures.

We are confident that these obstacles can be overcome and that the yard may take full advantage of the savings in welding time, man power, welding electrodes and to some extent in operative skill and training time.

Introduction

In an effort to adjust welding practices at the yard of the California Shipbuilding Corp. to the wartime conditions of increased production, and at the same time being faced with a severe curtailment of man power and materials, the Welding Engineering Dept. has embarked upon a program of testing and development of new welding techniques.

It has always been recognized that the use of large-diameter electrodes should be increased to the maximum commensurate with available equipment and experienced personnel. As a result the estimate of electrode requirements was revised on July 20th to add 4% of $^5/_{16}$-in. electrode, increasing the percentage per hull of electrodes of $^7/_{32}$-in. size and over from 30 to 34%. The use of larger-size electrodes together with the use of positioning devices has enabled the Plate Shop and Sub-Assemblies to show marked increase in total production and in units per man-hour.

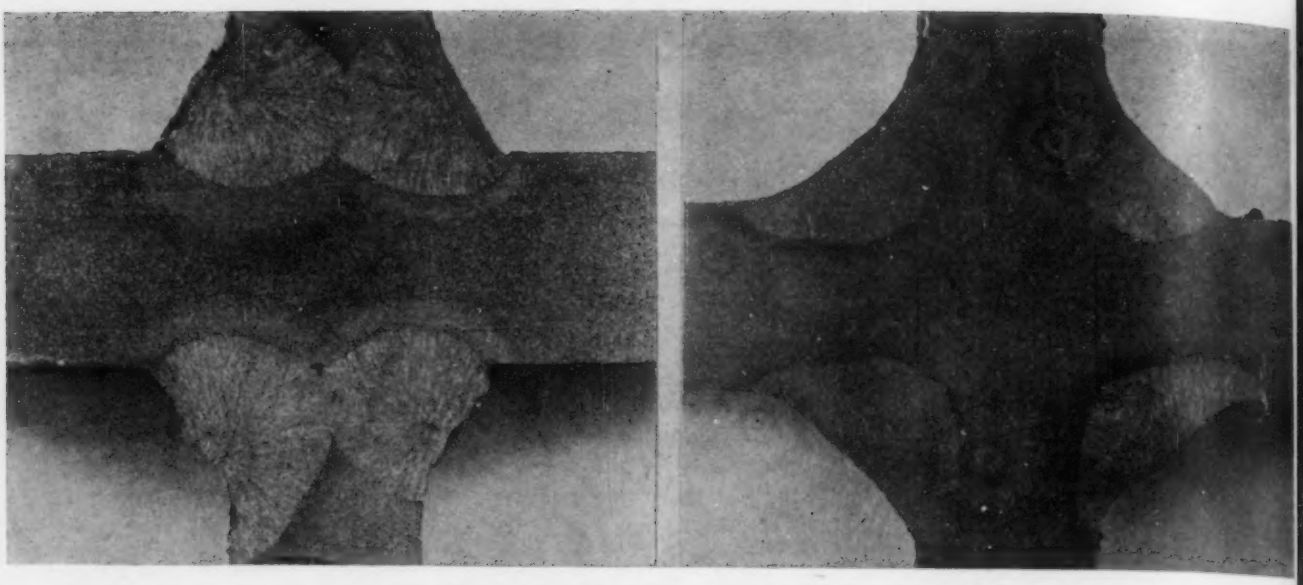
However, increases in the ultimate production by this means are limited because of the limitations in the number of welding machines of sufficient capacity to handle large electrodes and in the number and size of positioning devices. Hence, some other means had to be found which would utilize existing equipment and increase production without increasing operator fatigue.

A large welding company has recently announced the development of a new electrode and welding technique known as the "Fleet Fillet" Welding Techn que for Speeding War Production.* This technique is based on the premise that the ideal fillet weld is one with complete penetration (see Fig. 1), i.e., one plate is fused completely to the other. Conventional fillet welds rely on metal deposited within the fillet and are built up to specified size of the fillet to produce adequate strength. Under conditions of complete penetration, a large fillet is no

* A report on tests conducted by the Welding Engineering Dept. of the California Shipbuilding Corp. for the purpose of studying the Fleet Fillet Welding Technique proposed by The Lincoln Electric Co., at California Shipbuilding Corp., Terminal Island, Calif., Nov. 1942.

† Welding Engineer, Mechanical Engineer and Engineer in Charge Testing Laboratory, respectively, of the California Shipbuilding Co.

* Bulletin 432, The Lincoln Electric Co., Cleveland, O., Sept. 1942.



Specimen D-35: 1/4-in. E-6020 electrode, 16 in. per minute, 80 v., 600 amp., a. c.

Specimen C-76: 1/4-in. E-6020 electrode, 6 in. per minute, 100 v., 275 amp., a. c.

Fig. 1—Ideal Fillet Weld with Complete Penetration (Left), Compared with Conventional Fillet Weld (Right)

longer of value for imparting strength since the two plates have been made into one continuous piece, and a small fillet serves only to reduce stress concentrations which would be present at a sharp corner. Furthermore, under the ideal conditions of complete penetration with a small fillet, the amount of filler metal deposited from the electrode is considerably reduced since the greater part of the fused metal is obtained from the plates being joined.

In order to obtain a maximum penetration it is necessary to use heavy-coated all-mineral electrodes and to increase the heat liberated at the arc, which can be done by increasing the welding current. Large welding currents require a large-diameter electrode to remain free from adverse effects upon the quality of the weld. It has been demonstrated in our laboratory that if an electrode becomes overheated by the resistance to passage of high currents to a point where it becomes red-hot, it melts off more rapidly than it would normally be consumed in the arc, the weld deposit builds up on the outside of the plates being welded and poor penetration results. On the other hand, large electrodes when used with conventional techniques leave a large weld-metal deposit. This fact, of course, is the reason for their development—to produce welds of the maximum size in the least number of passes.

Bearing these facts in mind, it was found that by using a suitable angle of the electrode, maintaining a shorter arc length and increasing the speed of travel, maximum penetration can be attained and the amount of deposited metal per lineal foot of weld can be reduced. Thus the manufacturer claims that the speed of welding in the flat or horizontal positions can be increased up to 100% and a 50–60 % saving can be effected in electrodes. This two-fold saving is effected in two of the most critical items in our war effort, man power and materials.

The Problem

Once these phenomena had been demonstrated and duplicated by members of our own staff, the Welding Engineering Dept. embarked upon a program of testing and development with the view of applying the technique to production as soon as possible. This program has become many-fold.

First, it was desired to confirm in detail the findings of the manufacturer.

Second, it was necessary to determine the quantities and types of electrodes on hand and on order which were adaptable to the technique and to determine the exact behavior of each type, inasmuch as it was hopeless to expect that a sufficient quantity of the rod developed by the manufacturer especially for this technique would be available to maintain operations in this yard.

Third, it was necessary to determine the limits of application and to establish definite and standardized procedures for the production work to follow.

Fourth, it was necessary to establish a testing program to certify skilled mechanics in this technique.

Fifth, it was necessary to provide quantitative physical data for the benefit of the local inspection services of the company, the Maritime Commission and the American Bureau of Shipping.

In addition it was necessary to provide means to identify deep fillet welds inasmuch as the normal criterion of leg length is no longer applicable.

The Project

The program undertaken to solve these problems consists of three steps.

The first is the accumulation of physical data. The methods used will be discussed in detail later in this report. The results obtained are serving many purposes. First, they have confirmed to our satisfaction the findings of the manufacturer. Second, they include data which allows comparison between the new "deep fillet" technique and the conventional technique. Third, they form the basis for the establishment of production procedure as discussed in the next step. Fourth, they have provided a starting point for further investigations and possible extension and improvement.

The second step is the establishment of production procedures. These procedures—relating to travel speed, length of arc, position of electrode and current and voltage adjustment for both a.-c. and d.-c. welding in the flat and horizontal positions—stem directly from the data obtained above. However, some additional complications are encountered because a precise current control is required for successful operation. The ac-

Fig. 2—View Showing General Arrangements of Test Setup and Equipment

cepted practice using conventional techniques is for the welding operator to select the approximate operating conditions by means of the dials on the welding machine and to make a final adjustment according to the behavior of his arc. This means that a considerable amount of skill and experience is required to obtain reproducible results and thoroughly sound welds. Such practices cannot be tolerated with the "deep fillet" technique because of the possibility of producing unreliable welds. The conventional design procedure for fillet welds is to assume that there is no penetration at the root of the weld and therefore to assume that the deposited metal outside the original boundaries will carry the full designed load. Under these conditions, a fillet weld made to the specified dimensions which appears to be sound will conform to all requirements of design and inspection. Deep fillets on the other hand depend for their strength on deep penetration well within the boundaries of the original plates. Therefore their strength cannot be reliably determined by external size or appearance.

It has been reliably demonstrated that results can be reproduced by maintaining conditions constant; and that with all other factors constant, the strength of the weld will be proportional to the current used in making the weld. Therefore, if a current value is selected, then all sound welds made with this current will have the same strength within the limits of strength required. Some method must be devised to give a reliable current setting under all operating conditions. This has been accomplished by measuring the power consumption required to produce a weld of a given strength in terms of the length of electrode consumed per minute. Since the amount of electrode melted is proportional to the power consumed and the operating voltage is constant within the required limits, then the burn-off rate is proportional to the current applied. When the correct burn-off rate for a given weld is determined, then it is only necessary to mark the current setting on the welding machine. The machine setting for this current can then be used for future readjustment.

The application of this procedure to yard practice will constitute a program of large proportions when one considers that machine settings must be established for "deep fillet" welds equivalent to 5 design weld sizes on approximately 500 machines to be utilized with this technique.

The third and final step in applying the "deep fillet" technique to yard practice is testing and training. The simplicity of the technique can reduce the training time to a fraction of that required for conventional technique. This was determined by making a flat fillet weld in the test laboratory by a person who had had no previous direct contact or experience with welding. The girl selected was given exactly 4 min. of instruction, which allowed her to get the feel of the arc and learn the proper travel speed. She then welded 4 fillets in the flat position, 12 in. long in the size equivalent to a $^{3}/_{8}$-in. fillet. The total time consumed was not over 12 min. from the time the subject struck her first arc. The test was made under the same conditions as all other tests

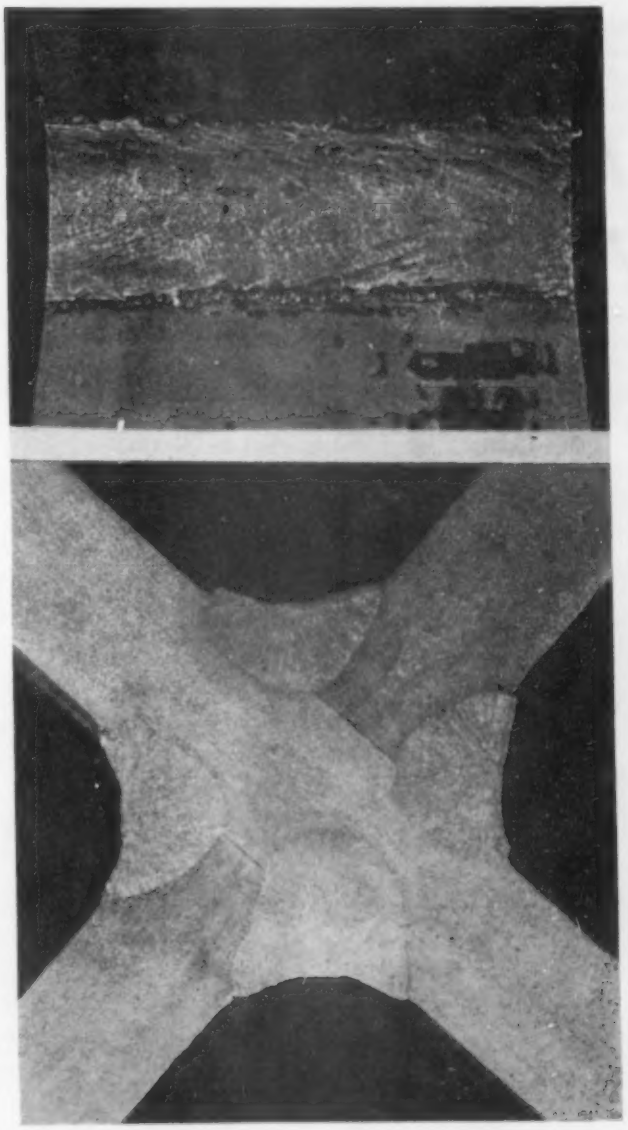


Fig. 3—Flat Fillet Weld Made by Inexperienced Girl After Only 4-Min. Instruction

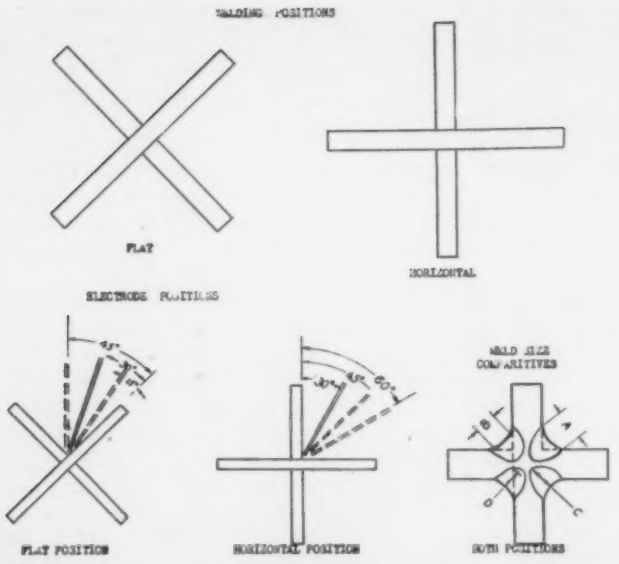


Fig. 4—Diagram of Test Procedure Showing Positions of Work and Electrodes and the Location of Weld-Size Measurements

connected with our researches into the "deep fillet" technique and the specimens were subjected to the same physical tests of tension and macrostructure. The results showed that the strength of the weld was in excess of the requirements of the AMERICAN WELDING SOCIETY for a $^3/_8$-in. fillet and the quality of the weld can be judged from the accompanying photographs (Fig. 2).

However the simplicity of the technique and the reduced time for instruction do not in any way eliminate the necessity for a training program even for the most experienced welders. The problem faced in instruction of qualified welders is one of prejudice. All of the procedure test specimens were made by welders selected at random from the Plate Shop and Sub-Assemblies, and all of these individuals expressed doubt as to the practicability of the technique in one or another of its phases. Welders must become accustomed to the new electrode position, the shorter arc and the increased travel speed; and most important of all, it must be assured that welders understand the new technique and are willing to conform to its procedures.

Testing will be a necessary addition to the training program to assure us that each operator thoroughly understands the new requirements. Because of the unusually large number of places where this technique can be applied in a yard of this size using the present methods of construction, it may be possible to qualify men for this procedure exclusively, thereby eliminating a great amount of the time spent on instruction of conventional techniques.

In summary, it has been the purpose of this project to study, with a view to its future application, a new welding technique which will bring about savings in those commodities where shortages are most critical, materials (welding electrodes) and man power.

These studies have resolved themselves into three interrelated projects:

1. The accumulation of physical data and the confirmation of results of the manufacturer.
2. The development of procedures and establishment of yard practice.
3. Training and testing of welding operators.

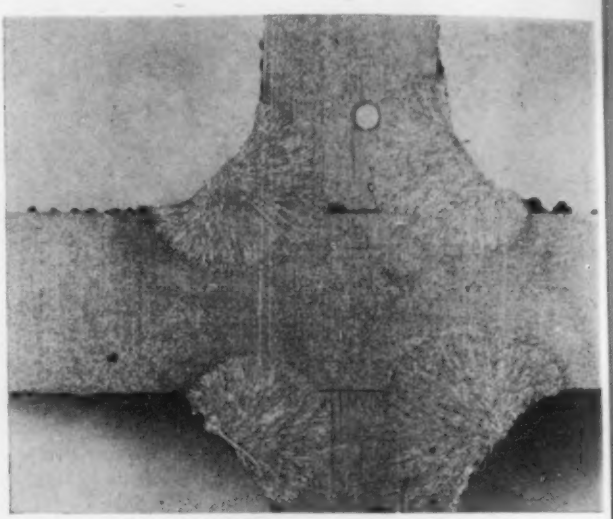


Fig. 5—Specimen C-99 Showing the Effect of Welding Current on Penetration

One-fourth-inch E-6020 electrode, 12 in. per minute, 100 v., 300, 400, 450, 500 amp.

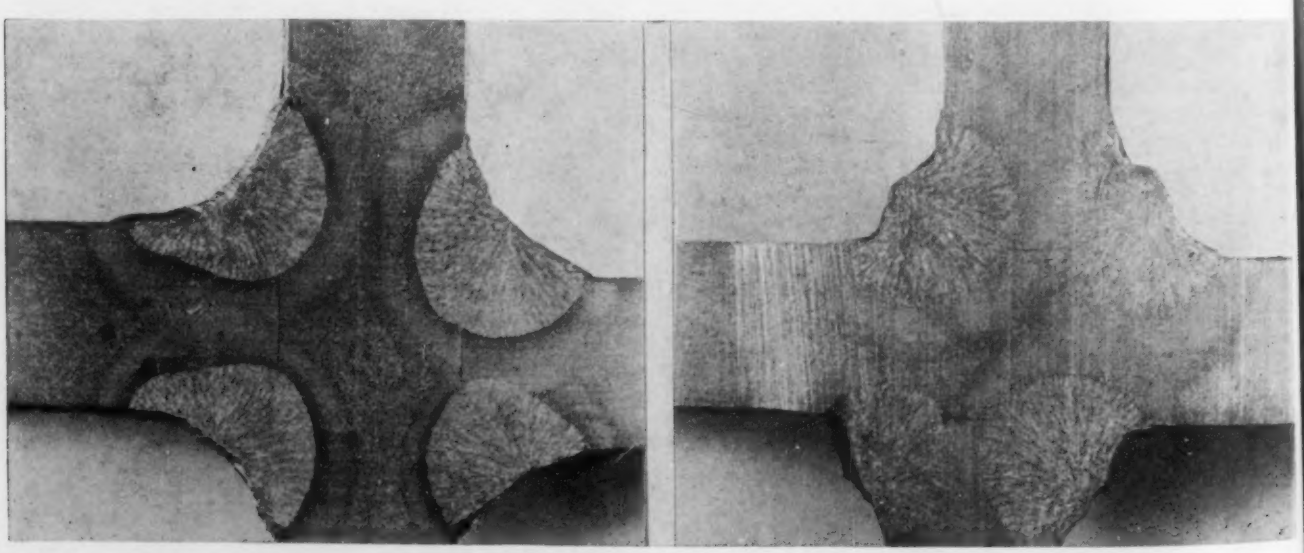


Fig. 6—Specimens D-14 and D-15 Showing the Effect of Welding Up and Down a Slope

Specimen D-14: $^1/_4$-in. E-6020 electrode, 12 in. per minute, 100 v., 500 amp., a. c., downhill.

Specimen D-15: $^1/_4$-in. E-6020 electrode, 12 in. per minute, 100 v., 500 amp., a. c., uphill.

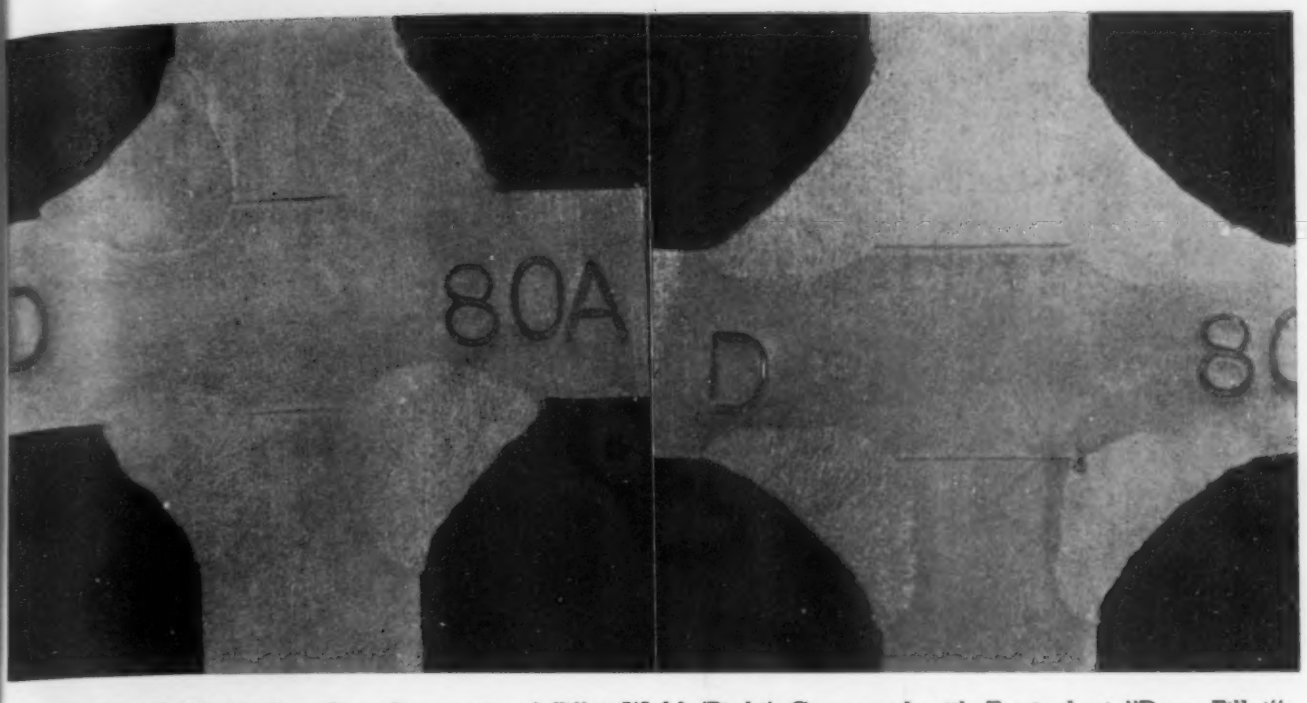


Fig. 7—One-Half-Inch Leg Size Conventional Fillet Weld (Right) Compared with Equivalent "Deep Fillet" Weld (Left)

Deep fillet weld made at 12 in. per minute. Conventional fillet weld made at 5 in. per minute.

Test Procedure, Results, Data and Analysis

Equipment

The equipment used in making the sample welds was selected from and representative of welding equipment used throughout the yard. For a. c. a heavy-duty 500-amp. (rated) welding transformer was used; and for d.-c. tests a 300-amp. welding generator was employed. These machines were set up in a small room adjoining the Testing Laboratory especially for experimental purposes (Fig. 3).

Material

All welding specimens were made up on cross sections prepared by tacking two 5-in. stiffeners on either side of a 10-in. plate. The length of the assembly was 24 in. These stiffeners were centered on the 10-in. plate and lined up carefully to reduce bending stresses to a minimum during the tension test. These assemblies supported themselves for welding in the flat position or were supported in a jig for welding in the horizontal position.

The electrodes used for these tests were of the AMERICAN WELDING SOCIETY Specification E-6020 and E-6030. The majority of the specimens were made with $^1/_4$-in. and developed for this purpose (E-6020); but tests were made for comparative purposes with $^3/_{16}$-, $^1/_4$- and $^5/_{16}$-in. E-6030 and $^3/_{16}$ and $^7/_{32}$-in. rods of other manufacturers of the same A.W.S.-A.S.T.M. Classification, E-6020 and E-6030.

General Procedure

Single-pass welds were made on either side of each stiffener. Sample welds were made in both the flat and horizontal positions using a.c. Welds were made in the same manner with d.c. but in the flat position only. Welding operators for these tests were selected from the Plate Shop and Sub-Assemblies.

The plates were laid out with soapstone markings at intervals equivalent to 15-sec. welding time. For example, for a weld made at a travel speed of 12 in. per minute, the plate was laid out in 4 segments, each 3 in. long. This enabled the operator to check his speed at each 15-sec. interval. All welds were run for an interval of 1 min. except those run at speeds in excess of 20 in. per minute, in which case the plates used were not long enough to accommodate a weld of 1-min. duration so a shorter time interval was used. The plate thickness used was variable. The size was selected in an effort to cause failure in the weld during the tension test.

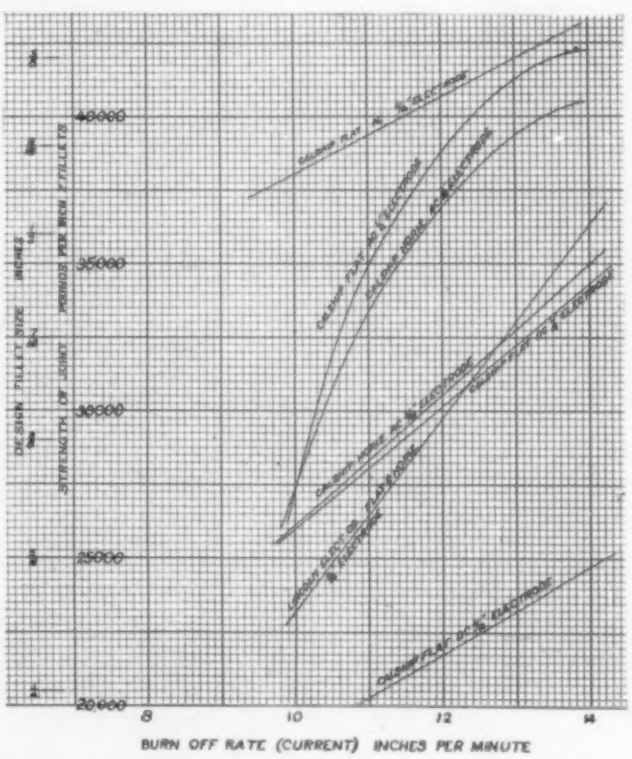


Fig. 8—Curves Showing Relation of Strength and Size to Burn-Off Rate of Electrode (Current)

Data noted at the time of welding included type of current, open circuit voltage, machine setting of current, presence and number of cracked fillets, electrode and size, travel speed, angle of electrode and electrode burn-off rate.

Two test specimens $1^1/_2$ in. wide were machine cut from each sample. One was cut down to 3 × 3 in., ground, polished and etched for macrostructure. The other specimen was lightly etched without edge preparation and measurements of weld size and penetration taken as indicated in Fig. 4. Minimum dimensions of the plate in this specimen were determined and a tension test applied until failure resulted. The location of the failure (plate or weld) was noted and record was kept of imperfections in the weld.

Initial Tests

A large number of initial test specimens were made up using $^3/_{16}$-in. E-6030 electrodes, $^7/_{32}$- and $^1/_4$- E-6020 electrodes in the flat position to determine the limiting rate of travel. Alternating current was used exclusively for these tests at both 80 and 100 v. open circuit with little regard for current setting, the current being adjusted as necessary to maintain good penetration and high fluidity. Travel speeds were taken over a range from 12 to 24 in. per minute. At this time certain specimens were made to cover particular conditions. Attention is called to Specimen C-99 (Fig. 5) in which the 4 fillets were made at different currents to show the effect of current on penetration, soundness and appearance.

Also Specimen D-14 (Fig. 6) was welded down a $7^1/_2°$ slope and Specimen D-15 was welded up a $7^1/_2°$ slope. Tests from D-12 to D-51, inclusive, were made at an electrode angle of 30° and 15° rather than the recommended 45° (see Fig. 4). This was done to direct the arc in an effort to obtain more complete penetration at the joint. Results of the test show that this technique is practical in the flat position.

On the last 17 tests the electrode burn-off rate was recorded as a basis for establishing proper current.

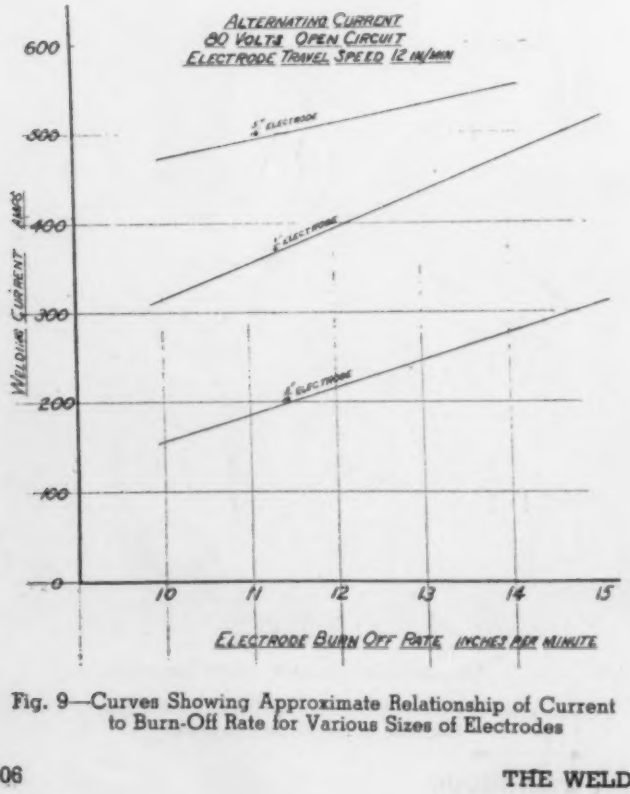


Fig. 9—Curves Showing Approximate Relationship of Current to Burn-Off Rate for Various Sizes of Electrodes

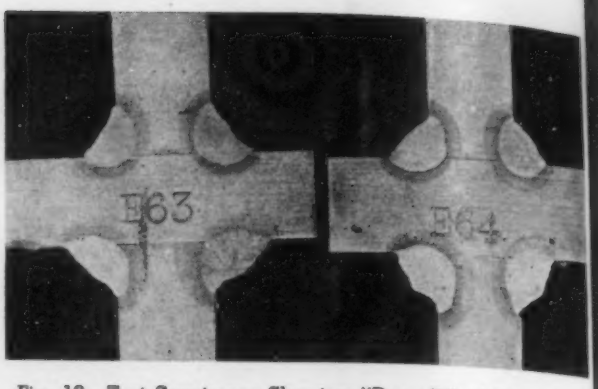


Fig. 10—Test Specimens Showing "Deep Fillet" Welds (Top) and Single-Pass Conventional Fillet Welds (Bottom) Welded on Same Sample

From these tests the following procedure table was made up. A portion of a table from the paper on Fleet Fillet Welding Technique published by the manufacturer is shown for comparison (Table 1).

Table 1

Manufacturer

Plate Size, In.	Burn-Off Rate, In./Min.	Current Amp.	Arc Speed, In./Min.	Electrode Size, In.	Ultimate Strength, Lb./In.
$^1/_4$	9	250	13	$^1/_4$	15,000
$^5/_{16}$	9	250	13	$^1/_4$	18,750
$^3/_8$	$9^3/_4$	275	13	$^1/_4$	22,500
$^1/_2$	$12^1/_2$	350	13	$^1/_4$	30,000

California Shipbuilding Corp.

Drawing Fillet Size, In.	Current Amp.	Electrode Size, In.	Arc Speed, In./Min.	Burn-Off Rate, In.	Ultimate Strength, Lb./In. A.W.S.
$^3/_{16}$	150	$^3/_{16}$	11–13	$11^1/_2$	15,500
$^1/_4$	200	$^5/_{16}$–$^7/_{32}$	11–13	$^3/_{16}$*–15	20,500
$^5/_{16}$	275	$^7/_{32}$–$^1/_4$	11–13	$^7/_{32}$*–13 $^1/_4$*–10	25,000
$^3/_8$	325	$^1/_4$	11–13	$11^1/_2$	29,000

* Size of electrodes

Confirmation Tests

The remaining tests specimens were made on the basis of the above table for the purpose of confirming it. Two sets of specimens were welded in the flat positions; one with a. c. and one with d. c. These specimens were made up according to the general procedure outlined above and the same data taken. All of these tests (both a. c. and d. c.) were made at a travel speed of 12 in. per minute and with an electrode angle of 30° measured from the plate. Electrodes used were $^3/_{16}$ in. and $^5/_{16}$-in. E-6030 and $^1/_4$-in. E-6020. For comparative purposes 2 specimens were made with fillets welded according to conventional techniques (Fig. 7). These were of the $^1/_2$-in. size single-pass and were made with $^5/_{16}$-in. E-6030 at 5 in. per minute and $^1/_4$-in. E-6030 at 4 in. per minute.

One additional set of specimens was welded under the same general conditions with a. c. in the horizontal position. Two changes were made in the procedure for the horizontal position. First, the travel rate was reduced from 12 in. per minute to 10 in. per minute; and second, the angle of electrode was changed from 30° measured from the plate to 30° measured from the stiffener (see Fig. 4). This actually directs the arc into the plate rather than into the joint but the change is necessary to prevent undercutting of the vertical member.

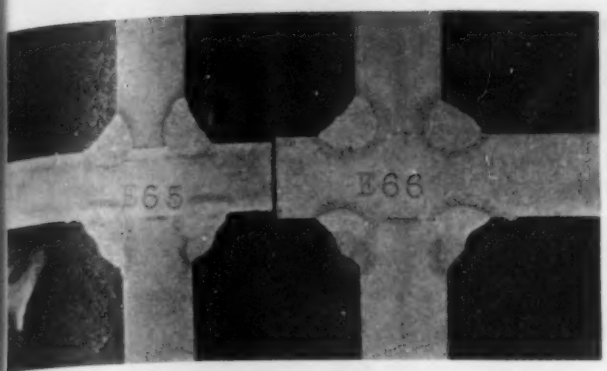


Fig. 11—Test Specimens Showing "Deep Fillet" Welds (Above) and Two-Pass Conventional Fillet Welds (Below) Welded on Same Sample

Two test specimens were cut from each of these sample welds. One of these was ground, polished and etched for macrostructure; the other was tested in tension to failure.

Figure 8 shows the relationship between the strength of deep fillet welds and the current used to produce them measured in terms of the burn-off rate of electrode. Superimposed upon the scale of strength of joint is shown the scale of fillet weld sizes corresponding to this strength. These values have been taken from Navy specifications as quoted in the *Welding Handbook* (AMERICAN WELDING SOCIETY, 1942). The weld sizes shown here are for fillets welded according to conventional techniques. These curves show the proper current selection to produce deep fillet welds equivalent to the conventional fillets of the size shown. These curves cover the following conditions:

1. Flat position.
   - (*a*) Alternating current.
     - (1) $^{3}/_{16}$-in. electrode.
     - (2) $^{1}/_{4}$-in. electrode.
     - (3) $^{5}/_{16}$-in. electrode.
   - (*b*) Direct current.
     - (1) $^{1}/_{4}$-in. electrode.
2. Horizontal Position.
   - (*a*) Alternating current.
     - (1) $^{3}/_{16}$-in. electrode.
     - (2) $^{1}/_{4}$-in. electrode.

Figure 9 shows the approximate relationship between burn-off rate of electrode and the welding current in amperes. Please note that these currents are actual welding currents and not machine settings. When applying this procedure, the welding current should always be adjusted by checking the burn-off rate of electrode.

In addition to their value in selecting the proper current for a weld of given strength, these curves indicate other interesting features of the technique. In every case, a. c. gave a weld of superior strength to d. c. for the same burn-off rate and electrode size. The increased effectiveness of a. c. seems to be the result of greater penetration resulting from the agitation of the molten pool which is caused by the current reversals 120 times per second. Furthermore, a.-c. welds showed a greater range of application for a given set of conditions within the limits of machine capacity. This is shown by the increased rate of change of the strength of joint with respect to the burn-off rate (current). It is significant to note that the slope of the curve of the manufacturer's recommendations could not be reproduced with the d.-c. equipment available in this yard. However, this does not mean that the available d.-c. equipment is not suited to this technique. The tests show that good results are obtainable for fillet sizes corresponding to $^{5}/_{16}$- and $^{3}/_{8}$-in. design size.

It should be noted that the arc speed of horizontal welds was reduced from 12 in. per minute to 10 in. per minute. This was done to assure a sound-appearing weld and to allow time to fill undercut in the vertical member. This in turn has an influence upon the electrode position, since the reduced speed sometimes makes it necessary to tilt the electrode in the direction of motion to prevent the molten pool from running back and extinguishing the arc.

For an additional comparison, four samples were made to compare "deep fillet" and conventional techniques on the same sample. Specimen E-63 (Fig. 10) shows a $^{5}/_{16}$-in. conventional single-pass fillet (below) and an equivalent "deep fillet" (above) made in the flat position.

The required strength of this weld was 25,000 lb. per lineal inch. Failure of this weld occurred in the conventional fillet at 29,640 lb. per inch. Specimen E-64 was the same as above except that it was made in the horizontal position. Again failure occurred in the conventional fillet; this time at 33,130 lb. per inch.

Specimens E-65 and E-66 (Fig. 11) were made with two-pass conventional fillets (shown below) with equivalent "deep fillet" (above) in the flat and horizontal positions, respectively.

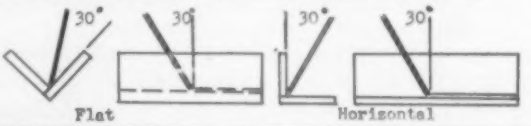
The required strength of these welds was 29,000 lb. per inch. Specimen E-65 (flat position) failed in the conventional fillet at 37,000 lb. per inch; while Specimen E-66 (horizontal position) failed in the "deep fillet" at 39,700 lb. per inch—more than 10,000 lb. per inch in excess of strength requirements. Flat-position "deep fillets" were made with $^{1}/_{4}$-in. E-6020 at 12 in. per minute. All conventional fillets were made with $^{7}/_{32}$-in. E-6012.

Adopted Procedure

With only a very few exceptions, all of these tests show that the strengths of "deep fillets" made according to Table 1 are in excess of design requirements. This would indicate that by further investigations it might be possible to make additional savings in electrodes and man-hours by slight increases in arc speed or savings in power consumption by decreases in welding currents. However, since the proposed table was based largely on the recommendations of the manufacturer, who had already received American Bureau of Shipping and United States Maritime Commission approval of their technique and procedure, it seemed advisable not to alter the procedure, but to use the additional strength as a safety factor against the possibility of irregular production work. To include work in the horizontal position, it was de-

California Shipbuilding Corporation

Procedure for Deep Fillet Welding Technique, Down Hand Position using A.W.S. E-6030 heavy all-mineral coated electrodes.



Drawing Fillet Size inches	Electrode Size inches	Recommended Travel Speed Flat	Horiz.	Electrode Burn Off Rate inches/ minute
3/16	3/16	12	10	11 1/2
1/4	3/16	12	10	15
5/16	1/4	12	10	10
3/8	1/4	12	10	11 1/2
7/16	1/4	12	10	12 1/2
1/2	1/4	12	10	14
1/2	5/16	12	10	12

Fig. 12—Table of Adopted Procedures

cided to use the same conditions as established for flat work but to reduce the arc speed to 10 in. per minute to reduce the possibility of undercutting the vertical number. The proposed procedure in tabular form with sketches indicating the electrode positions is shown in Figure 12.

The electrode angles were established for the flat position as 30° from the plate and 30° leading from the vertical. This arrangement assures maximum penetration into the joint and keeps the molten pool away from the arc at the adopted 12 in. per minute travel speed. The same lead angle was adopted for the horizontal position, but the angle with the plate was changed to 60° to eliminate undercut in the vertical member.

Welding Training*

A VARIANT of the regular trainee and upgrade programs is found in the training of welders. This program also has two stages: the first is intended to produce tack welders, and the second, arc welders. In both cases the training problem resolves itself into repetitive practice until a sufficient degree of manipulative skill, essentially a dexterous wrist motion, is acquired.

It is not practical to give this type of training on the job because of spoilage, and it is therefore necessary to route the steel plate scrap from the plate shop to the welding school where student burners (a profitable parallel training course) will cut the scrap into exercise pads of suitable size for use by the welding students. After having served this double training purpose, this scrap will then find its way to the electric furnace for remelt.

To serve its full purpose, the building which houses welding training should be designed for that purpose only, since the elimination of heat and fumes as well as the shielding of the arcs must be provided. Essentially, booths are placed in rows along the centerline of an A-roof building, each booth being open at the top and bottom to permit the free flow of air. Resistors are located high in the ceiling so that the heat may be more readily dissipated. A blower delivers fresh air into each booth near the bottom, and fans exhaust both heat and fumes through ventilators in the ridge of the roof. Each booth is provided with a switchboard so that the student may adjust current values.

Within the individual booth there are a table (actually the top of the fresh air duct) and a welding stand, which is a vertical frame supporting a tilting plate, shoulder high. This adjustable stand, hinged horizontally along the center, permits welding either vertically or overhead. Flat welding is done on the table top.

Wide aisles are located along the side walls of the building. At convenient points water troughs are placed so that the specimen may be cooled for examination. Close by is a metal-top table on which the student may clean his specimen with hammer and wire brush. There is also a hydraulic jack to be used in fracturing the specimen for examination of the weld.

In the lobby, which also serves as an office, there are display boards of sample welds; here the learner may compare his work with standards. As far as possible everything is of fireproof construction.

There are two things to be taught the learner, (1) how to deposit metal, and (2) how to use this newly acquired skill in joining metal. The list of exercises used in training both tack welders and arc welders is given below:

Lesson No.		Arc	Tack
1	Single beads in flat position	X	X
2	Double beads in flat position	X	X
3	Pad of crossing beads in flat position	X	X
4	Single beads in 45° flat position	X	X
5	Double beads in 45° flat position	X	X
6	Pad of crossing beads in 45° flat position	X	
7	Single beads in vertical position	X	X
8	Double beads in vertical position	X	X
9	Pad of crossing beads in vertical position	X	
10	Single beads in 45° overhead position—welding upward	X	X
11	Double beads in 45° overhead position—welding upward	X	X
12	Pad of crossing beads in 45° overhead position	X	
13	Single beads in overhead position	X	X
14	Double beads in overhead position	X	X
15	Pad of crossing beads in overhead position	X	
16	1/4-In. fillet weld in flat position	X	X
17	5/16-In. fillet weld in flat position	X	
18	3/8-In. fillet weld in flat position	X	
19	1/4-In. fillet weld in vertical position	X	X
20	5/16-In. fillet weld in vertical position	X	
21	3/8-In. fillet weld in vertical position	X	
22	1/4-In. fillet weld in overhead position	X	X
23	5/16-In. fillet weld in overhead position	X	
24	3/8-In. fillet weld in overhead position	X	
25	Lap weld in flat position	X	
26	Lap weld in vertical position	X	
27	Lap weld in 45° overhead position—welding upward	X	
28	Lap weld in 45° overhead position—welding horizontally	X	
29	Lap weld in overhead position	X	
30	Butt weld in flat position	X	
31	Butt weld in vertical position	X	
32	Butt weld in overhead position	X	

Three courses of training are possible. The new employee may be given only the basic training included in the tack welding course, and sent out into the yard as a tack welding helper. Those who prove themselves apt during training may be given all the exercises and then be transferred to the welding department as arc welders. Again tack welding helpers may be returned to the school after a few months of experience, and brought to the arc-welding level: Eighty to 90 hr. are needed to train a tack welder; 200 to 220 hr. for the full welding course; and from 60 to 80 hr. for the tack welder to complete the remaining exercises to become an arc welder. In some plants the school is operated on a 24-hr. daily schedule with one instructor provided for each group of 20 students. The number of men turned out from such a welding school during the present crisis is one of the most amazing accomplishments in the whole field of training.

* Extract from an article entitled "The Wartime Training of Shipbuilders," presented at Annual Meeting of The Society of Naval Architects and Marine Engineers, by G. Guy Via, Supervisor of Training, Newport News Shipbuilding & Dry Dock Co.

The Application of Welding in Structural Design

By Simon A. Greenberg*

MUCH consideration is being given today to a program of postwar construction with the two purposes of resuming construction programs halted by the war, and the employment of the newly created supply of skilled labor.

It is expected that the postwar program will include housing and municipal development so that the structural engineer will be required to assume a large share of the work. In the preparation of his designs the structural engineer may avail himself of the new engineering developments and the improved utilization of existing tools and processes resulting from the increased demands of the war effort which industry has had to meet.

Welding has been employed more widely and more advantageously than heretofore, and many of the difficulties previously encountered have been eliminated.

The problems of welding procedure, fatigue stresses, resistance to impact and similar design factors have been investigated and information on these questions is generally available.

The trend toward the rigid- and semi-rigid frame structures, from the standpoint of engineering as well as "functional design," has been greatly enhanced by the sound application of welding.

The increase of welding operators both as to number and skill and the installation of welding equipment in more of the fabricating shops forestall any difficulty in either the fabrication or erection of structures whose designs have otherwise indicated advantages to be gained by welding in lieu of riveting.

Finally in any design due consideration must be given to local building laws and any possible restrictions that may be imposed on the application of welding in construction within their jurisdiction.

In an effort to determine both the extent and nature of such restrictions, the Committee on Building Codes of the AMERICAN WELDING SOCIETY has undertaken a poll of cities in the United States with regard to the provisions for welded construction contained in their building codes. The information compiled to date is shown in Table 1. It should be noted that all of the principal cities in the U. S. permit welding in place of riveting in construction.

The Committee on Building Codes of the AMERICAN WELDING SOCIETY has prepared a "Code for Arc and Gas Welding in Building Construction" covering all aspect of welded construction such as: Design, Workmanship, Filler Metal and Operator Qualification. In addition proper weld contours are indicated as a guide to the inspection of welded construction. This Code is so arranged that it may be incorporated into existing building codes or may be adopted by citation.

In addition to the cities which have employed this Code in the adoption of welding provisions for their codes, the American Institute of Steel Construction and

* Assistant Technical Secretary, A.W.S.

Table 1

Cities Whose Building Codes Have Welding and Cutting Provisions in General Conformity with the Provisions of the A.W.S. Code

Cities Over 100,000 Population

Birmingham, Ala.	Omaha, Neb.
Bridgeport, Conn.	Peoria, Ill.
Charlotte, N. C.	Portland, Ore.
Chicago, Ill.	Richmond, Va.
Cleveland, Ohio	Rochester, N. Y.
Dallas, Tex.	Sacramento, Calif.
Denver, Colo.	St. Paul, Minn.
Des Moines, Iowa	Salt Lake City, Utah
Detroit, Mich.	San Diego, Calif.
Erie, Pa.	Scranton, Pa.
Jacksonville, Fla.	Seattle, Wash.
Knoxville, Tenn.	Springfield, Mass.
Long Beach, Calif.	Syracuse, N. Y.
Los Angeles, Calif.	Trenton, N. J.
Miami, Fla.	Utica, N. Y.
Minneapolis, Minn.	Wichita, Kans.
New Bedford, Mass.	Wilmington, Del.
New Orleans, La.	Washington, D. C.

Cities 50,000 to 100,000 Population

Allentown, Pa.	Manchester, N. H.
Austin, Tex.	Newton, Mass.
Beaumont, Tex.	Phoenix, Ariz.
Berkeley, Calif.	Pueblo, Colo.
Binghamton, N. Y.	Saginaw, Mich.
Charleston, W. Va.	San Jose, Calif.
Charleston, S. C.	Santa Monica, Calif.
Corpus Christi, Tex.	Schenectady, N. Y.
Davenport, Iowa	Shreveport, La.
El Paso, Tex.	Sioux City, Iowa
Fresno, Calif.	Springfield, Mo.
Glendale, Calif.	Stockton, Calif.
Huntington, W. Va.	Topeka, Kans.
Irvington, N. J.	

Cities Permitting the Use of Welding Under Own Provisions

Cities Over 100,000 Population	*Cities 50,000 to 100,000 Population*
Atlanta, Ga.	Madison, Wis.
Baltimore, Md.	Pasadena, Calif.
Duluth, Minn.	Racine, Wisc.
Newark, N. J.	Rockford, Ill.
New York, N. Y.	
Philadelphia, Pa.	
Pittsburgh, Pa.	
San Francisco, Calif.	
St. Louis, Mo.	

Cities Permitting Use of Welding by Special Permit

Cities Over 100,000 Population	*Cities 50,000 to 100,000 Population*
Boston, Mass.	Altoona, Pa.
Buffalo, N. Y.	Atlantic City, N. J.
Canton, Ohio	East Orange, N. J.
Dayton, Ohio	Evanston, Ill.
Grand Rapids, Mich.	Greensboro, N. C.
Hartford, Conn.	Lancaster, Pa.
Kansas City, Mo.	Niagara Falls, N. Y.
New Haven, Conn.	Passaic, N. J.
Norfolk, Va.	Portland, Maine
Oklahoma City, Okla.	Quincy, Mass.
Providence, R. I.	Troy, N. Y.
Youngstown, Ohio	Waterloo, Iowa
	Wheeling, W. Va.

the National Board of Fire Underwriters, Building Codes employed by many cities, have adopted welding provisions based on those contained in the AMERICAN WELDING SOCIETY's Code.

The Committee on Building Codes will be glad to assist any code-writing body engaged in the revision of its building code with regard to provisions for the use of welding.

Silver Brazing and Its Application in War Work*

By C. M. Robbins†

TO COMPLETELY cover the subject it will be necessary to go back about ten years as the present use of silver brazing alloys did not just come about as the result of the necessity for a substitute material for brazing but it is the result of ten years of research, development and engineering work carried on by our engineers and laboratory technicians. When the War Dept. required a high-strength brazing alloy that would join both ferrous and non-ferrous metals and still flow at a low temperature, they knew what silver brazing alloys would do as they already had them in their specifications and no extensive research and development work was necessary. Since the start of the war tons of this material have been used where ounces were required in peacetime. Millions of silver-alloy brazed joints are being made every month.

I will mention a few examples where this material is used. A modern airplane has over 400 brazed parts. Every torpedo has several hundred brazed joints. A large ship contains over 8 miles of piping that is joined with silver alloy rings built into tees, elbows and other pipe fittings. I believe the greatest single war use of silver brazing alloys is in the manufacture of bombs and shells. Sections of the 20- and 40-mm. guns, the water jacket of the Bofors guns and even parts on the latest bomb sights are silver brazed. All of this work and many more applications can be pointed out, including one feature that I cannot miss due to its close connection with the war effort, which is the repairing of high-speed tools, milling cutters, drills, taps, broaches, etc. This is made possible by using low-temperature brazing alloys. Tungsten carbide tips are being put on with silver brazing alloys. The simplicity and ease in doing this work make it possible for an unskilled operator to do a perfect job with very little instruction and experience. No complicated equipment or expensive furnaces are necessary as any small shop with an acetylene torch can do this work.

Figure 1 shows a production job on shells. The adapter nose is brazed in this shell using a high-frequency induction heating machine.

Figure 2 shows an end plate for aircraft machine gun magazine formerly made from heavy forgings and machined. Now spiral strips are brazed to stampings. Production time has been cut from 32 min. to 5 min. and thousands of pounds of steel are saved.

Figures 3 and 4 show views of an aircraft radiator, one of the strongest pieces of evidence that silver brazing alloys make strong vibration-proof joints. The interesting example shown in these views is the Prestone radiator that is used in the Bell Airacobra. All tubes you see are brazed together and to the framework.

Figures 5 and 6 show special milling cutters that were repaired with a loss of only a little more than one point Rockwell from 64 to $62^1/_2$.

Figure 7 shows a $3^5/_8$-in. diam. drill that was badly shattered near the top end. As all of the pieces were not available it was necessary to cut out 1 in. of the drill. The parts were then cleaned and fluxed and a ribbon of 0.005 Easy Flo was inserted between the broken ends. A jig holding the drill in alignment was used and the drill was heated with an acetylene torch. A perfect joint was obtained and the drill worth about $300.00 was repaired with 8 cents worth of material and is still in service 4 months after the repairs were made.

Figure 8 is a deck-lighting fixture for ships, formerly cast aluminum but now a steel stamping brazed to cast brass rings.

The tap shown in Fig. 9 shattered into 10 pieces was repaired with 3 cents worth of Easy Flo in one-half hour's time. A new tap would take over 6 weeks to deliver. After 4 months of service this tap was still in use.

Figure 10 shows a forming tool. Dovetail cracked while in use on automatic screw machine. Repaired it gave over 6 months' additional service.

Figure 11 shows the nose piece for 100-lb. bomb brazed at high-speed production and gas-tight joints are obtained.

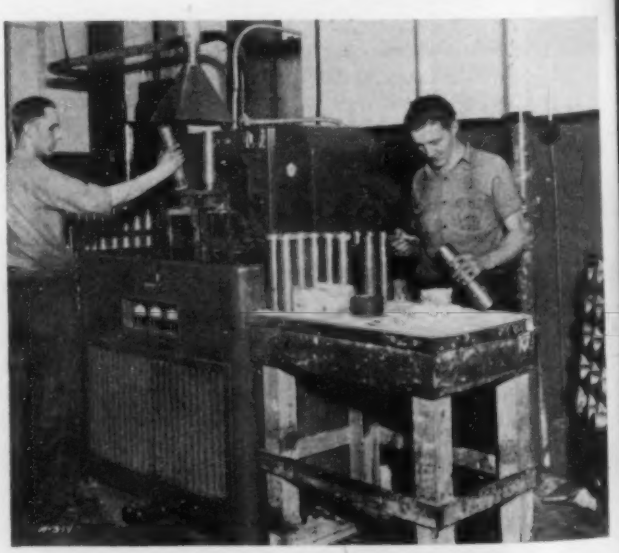
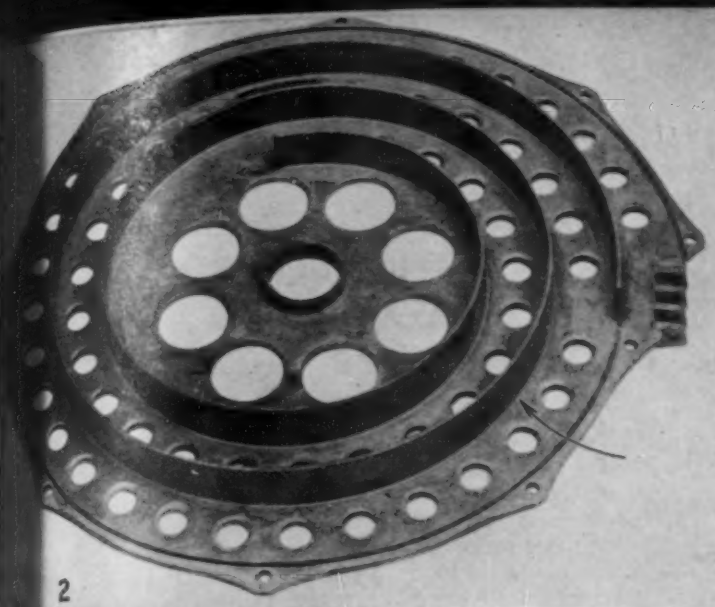


Fig. 1—Brazing Shells with Tocco Induction Heating Machine

* Presented at the February 26th Meeting of the Milwaukee Section, A.S.W.

† Handy & Harman.



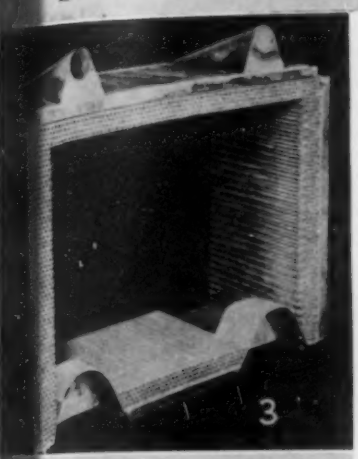


Fig. 2—End Plate for Aircraft Machine Gun Magazine

Fig. 3—Aircraft Radiator. Tubes Joined by Brazing

Fig. 4—Aircraft Radiator, Metals Joined Are Columbium Bearing 18-8 Stainless Steel, Rich Low Brass and Oxygen-Free Copper

Figs. 5 and 6—Special Cutters Repaired with Easy Flo

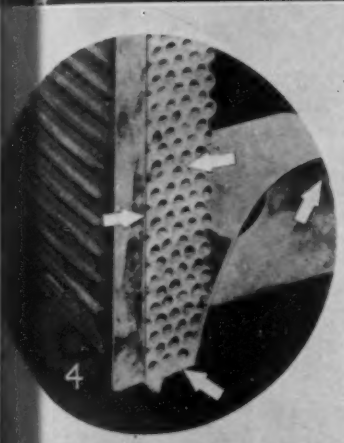
Fig. 7—Repaired Shattered Drill

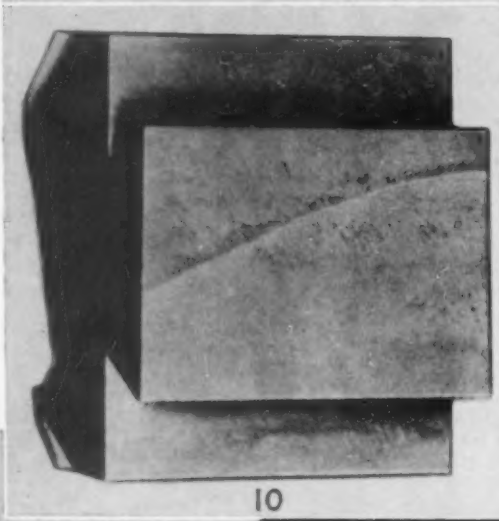
Fig. 8—Marine Deck-Lighting Fixture

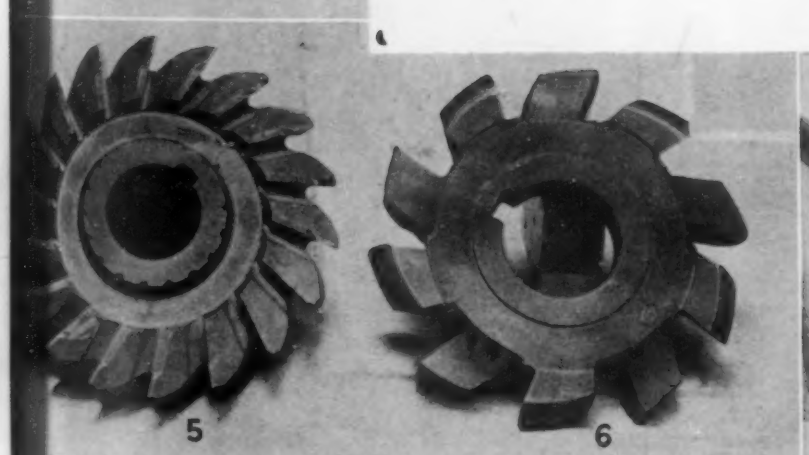
Fig. 9—Tap-Shattered Into 10 Pieces

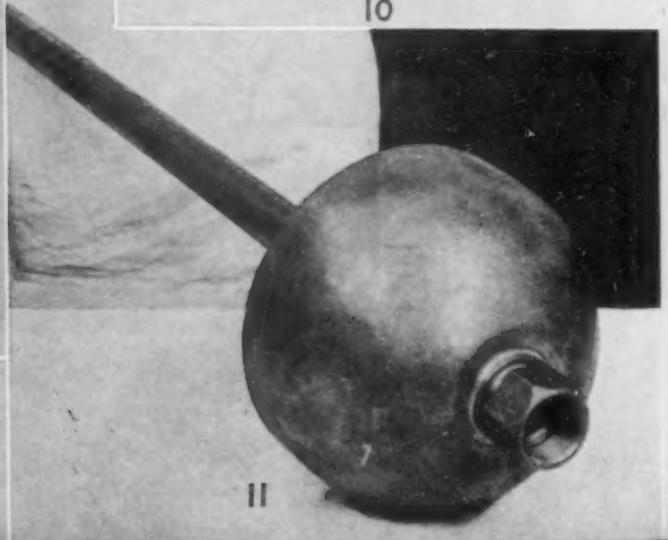
Fig. 10—Forming Tool Repaired with Easy Flo

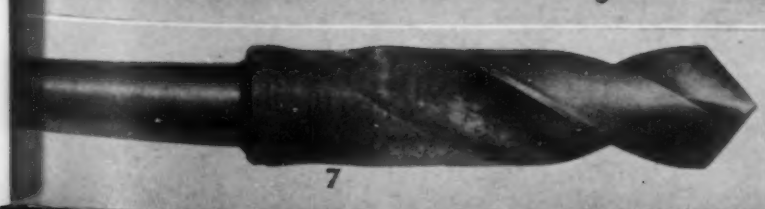
Fig. 11—Nose Piece for 100-Lb. Bomb











Welding in Aircraft Construction*

By H. O. Klinke†

Introduction

In recent years welding has progressed very rapidly in a great variety of fields including some applications wherein the joints are very highly stressed, such as pressure vessels, high-pressure and high-temperature piping, structural work, the transportation field including railroads, trucks and inland waterway and ocean-going vessels. As welding progressed in these various fields, there has accumulated in each of them a set of standards and design procedures particularly adapted to welded construction. This gradual accumulation of welding experience now places these industries at a point where the use of welded joints is a natural proceeding for the designer. It is almost impossible for the average designer accustomed to riveted or other joint design to switch over to welded construction simply by consulting a welding handbook. It is only by the experience of utilizing welded design repeatedly and gaining experience thereby, that the designer and the shop man can finally realize the full economy and speed to be derived from welded construction.

The possible applications of welding in aircraft construction are almost infinite and the utilization of this possibility to date is only beginning to be realized. There is every reason to assume that as welding has increased the speed and lowered the cost of fabrication in other fields, it will do likewise in aircraft construction if properly utilized. This requires not only the training of a shop organization to properly handle welding and an inspection organization properly trained to appreciate welding but further requires a design organization thinking in terms of welded design.

There are several obstacles that may at present be discerned that contribute to the relative slowness with which welding has been adopted by the aircraft builders during the years up to the beginning of this war. These obstacles are in every way similar to those which retarded the development of welding in other fields. Some of these obstacles are real as, for example, the training of an organization to properly use welding, and some are largely imaginary, as for example, the repeated statement heard from aircraft men "How can you be certain that the weld is a good weld?" The solution to these real obstacles can only be found, as has been the experience in other industries, by plunging in and using welding and learning by its utilization. This is so because many of the welding problems found in aircraft construction are peculiar to that industry and there is no previous identical experience in other industries where the solutions may easily be found. The solutions to most of the imaginary problems can most easily be solved by making the organization welding minded through the use of men trained and experienced in the proper application of basic welding principles. These men or a man should be placed in a position in the organization such that his experience may be directly utilized in the application of welding in design and so that he may properly establish a shop organization to carry out the designs.

A great deal of assistance could be given to the aircraft manufacturers, who at present are almost entirely working on Government orders, if the welding regulatory bodies of the Army and Navy would assist by the issuance of specifications and procedures which would embody the latest advances of the welding art. The restrictions at present felt by aircraft designers both real and apparent are numerous as, for example, the restriction against using weld metal in tension loading in arc- or gas-welded joints. The present rather narrow application of spot welding on aluminum sheet and extrusions is mostly due to a lack of knowledge by the designer of

* Paper presented at March 9th Meeting, New York Section, A.W.S.
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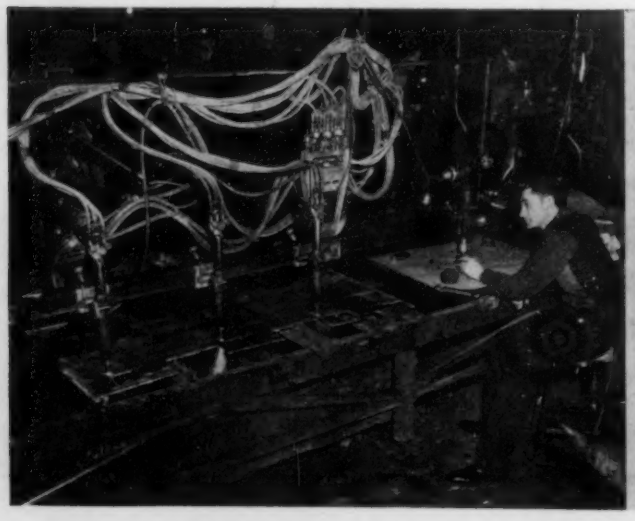


Fig. 1—Multiple Torch Gas Cutting Aids in Cutting Shapes for Steel

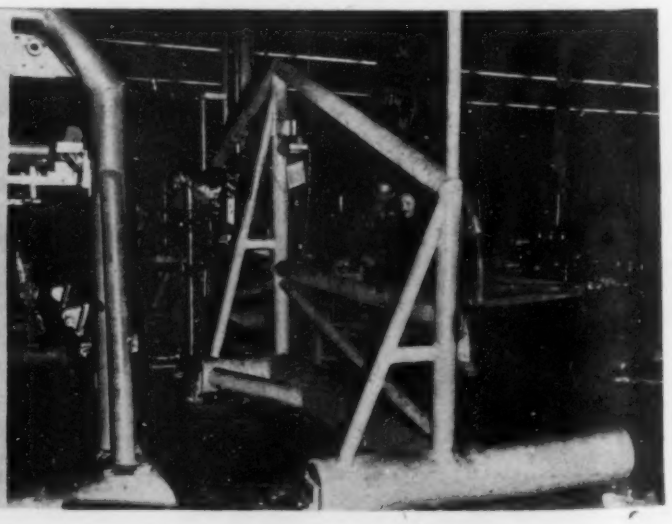


Fig. 2—Airplane Tail Assembly Jig

values that he may use in loading these welds. This is particularly true under vibratory loading and it is therefore particularly encouraging to receive recently a report on fatigue for these types of welds from the Battelle Memorial Institute. The use of spot welds in skin assemblies made of aluminum for wing or fuselage structure would seem very promising. Several tests recently made at Republic on the stiffness of such structure as compared to riveted structure indicated that the spot-welded assemblies were superior. It may be desirable when considering spot welds for primary aircraft structure to set up an inspection procedure using magnaflux or X-ray equipment which would insure a high consistency in spot-weld strength. Some recent work in the use of X-ray examination on spot welds has indicated that their quality may be readily checked by this means.

Inspection of Raw Material and Processing

Aircraft standards are high compared to those in many other fields and a rigid form of inspection is maintained on raw materials and all processing during construction of the ship. For example, all ferrous tubing is magnafluxed when received, it is magnafluxed again during processing and again on completion of assembly. Minute cracks are sufficient cause for rejection. Nonferrous castings and forgings are inspected by X-ray or ultra-violet means. Both gas and arc welders must pass rigid qualification tests set up by the Army and Navy. Automatic welding processes such as spot welding of aluminum are checked periodically during the day by making test specimens and pulling to destruction in a tensile machine. All of these factors contribute to the high quality obtaining generally in aircraft work.

Jigs

Since many of the parts both of ferrous and non-ferrous materials which go to make up an airplane are of irregular shape and contour, the use of holding fixtures or jigs during assembly is almost mandatory. These jigs are constructed of mild steel plate and pipe and are in many cases quite complicated and large in size. The jigs are of all-welded construction and standard methods of joint preparation and welding are utilized in their construction. Figure 1 shows a multiple torch gas cutting machine guided by a hand tracing unit cutting steel plate shapes to be used in the making of a typical jig. Figure 2 indicates an airplane tail assembly jig and shows the rugged construction frequently employed in the making of these fixtures. The locating or alignment points on these jigs must be held to rigid tolerances in order that the finished part will be accurate.

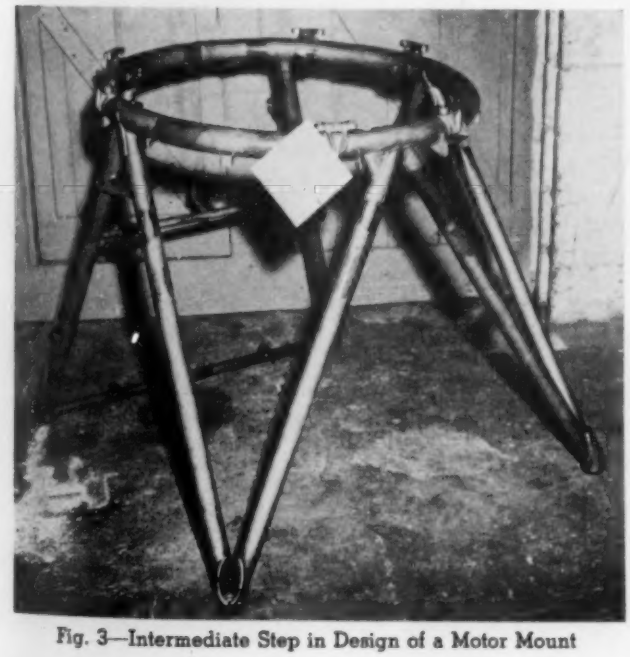


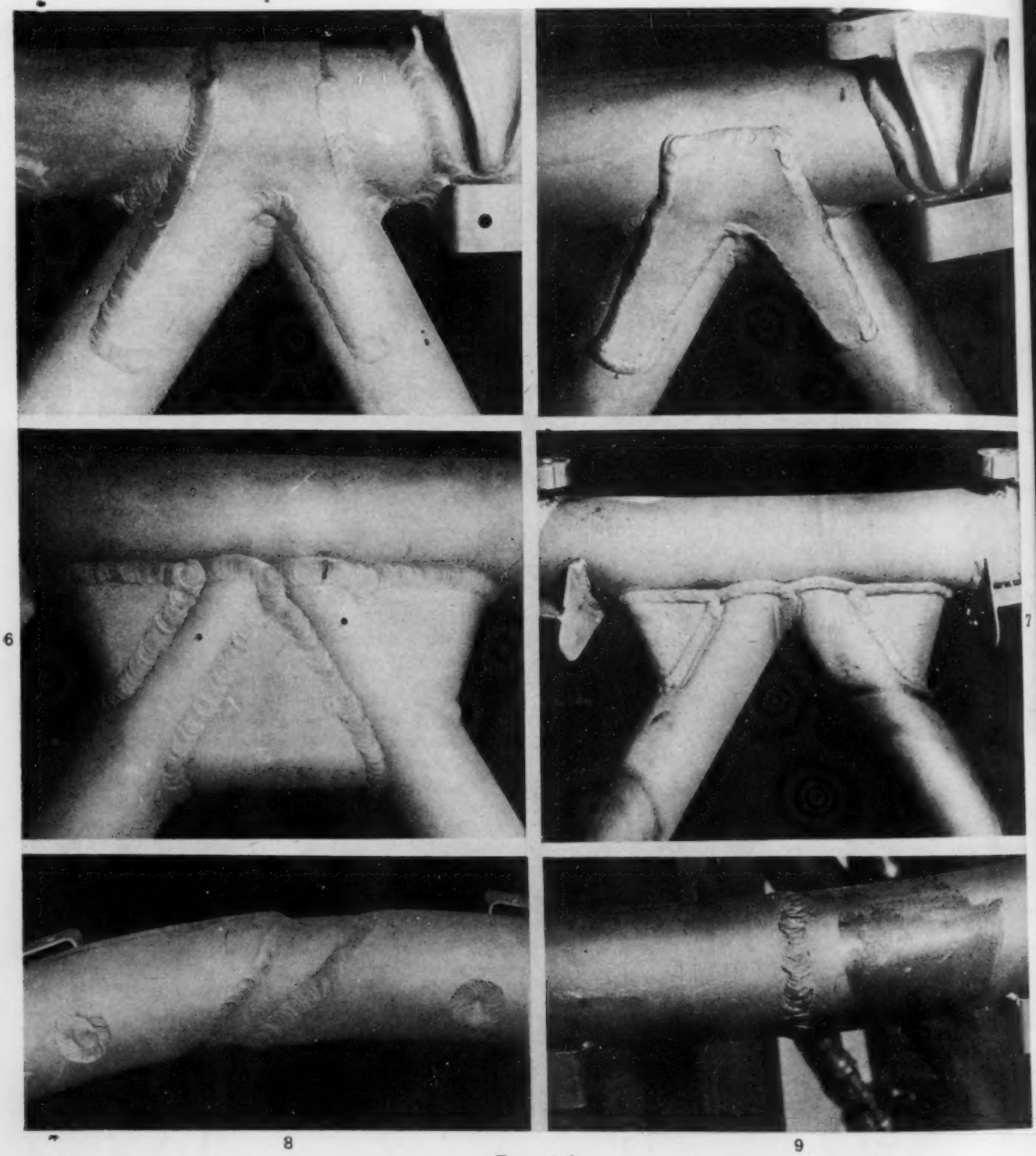
Fig. 3—Intermediate Step in Design of a Motor Mount

Arc-Welding Application

The use of arc welding in aircraft fabrication has increased very greatly in the past few years due to the increased speed obtained by its use over gas welding. The aircraft industry has been led in this changeover by the fabricators on the west coast, who have pioneered the use of arc welding. At present, almost every manufacturer uses arc welding in the construction of such assemblies as motor mounts and other heavy tubular and plate assemblies. This change to arc welding has been accelerated by the development and improvement in single-operator d. c. welding sets and the usability characteristics of small diameter electrodes. It is hoped that in the near future a companion development will occur in a. c. welding equipment and electrodes since these would seem particularly adaptable for use on aircraft structures. Figure 3 shows an intermediate step in the redesign and attempted simplification on the motor mount used in Republic's P-47 airplane. This motor mount is constructed of S.A.E. X4130 tubing and fittings and is used in the as-welded state. This permits, under Army specifications, a maximum unit stress of 80,000 psi. It would seem possible in view of the comparatively low unit stress permitted for this material when used in the as-welded state, to substitute a medium carbon manganese steel of equivalent section and it is probable that many future assemblies will be replaced by this lower cost material. It will be noted from Fig. 3 that many of the joints have been simplified in that fewer gussets and reinforcing straps are used than is generally prevalent in this type of assembly. Figure 4 shows a joint detail at the intersection of the circular ring and two leg members in a previous design in which the reinforcing strap is looped over the top of the ring. Figure 5 shows a preliminary attempt at simplification of this joint which adds greatly in reducing the assembly and fitting time of this joint. It will be further noted that Fig. 4 shows a gas-welded joint whereas Fig. 5 is arc-welded. Figure 6 shows a typical intersection of three members heavily reinforced with large box gussets. This joint is undesirable from the standpoint of a large amount of welding in a limited area with attendant overheating and burning of the parent material and the comparatively long time required to complete the welds. Figure 7 shows an intermediate simplification of this joint in which one gusset has been eliminated reducing the time and distortion obtained in making this joint. As before, Fig. 6 is gas welded and Fig. 7 arc welded. Figure 8 shows a widely used design for the joint in the circular upper ring of the motor mount. This joint consists of an inner sleeve extending approximately 6 in. into the tube ring on either side and to which the ring is welded by two fillets cut on an approximate 45° slope. In addition a number of rosettes are used to increase the linear inches of welding joining the ring to the sleeve. The reason for the 45° slope is to place the weld metal at least partially in shear rather than in tension. Figure 9 shows a redesign of this joint by a straight butt weld which has been welded over a

$^3/_4$-in. wide backing ring equivalent in thickness to the wall thickness of the tube equaling 0.094 in. This backing ring is not a strength member serving simply to insure full root fusion in the weld and results in a 100% joint, equivalent to a single vee joint reinforced both sides. The joint shown in Fig. 9 is much simpler, has great strength and calls for a minimum of welding to produce a satisfactory joint.

Figure 10 shows a number of arc welders assembling and welding a tubular structure called a crash skid. The complexity of the jig necessary to restrain and to hold in alignment this assembly will be noted from this figure.



Figs. 4–9

Fig. 4—Old Design in Intersection of Circular Ring and Two Jig Members
Fig. 5—Preliminary Attempt at Simplification of Joint Shown in Fig. 4
Fig. 6—Reinforced Intersection with Large Box Gussets
Fig. 7—Intermediate Redesign Eliminating One Gusset
Fig. 8—Old Design Using Inner Sleeve with Fillets and Rosettes
Fig. 9—Redesign of Fig. 8 Using Butt Joint

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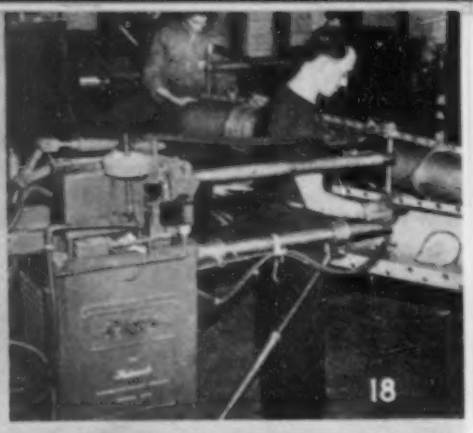
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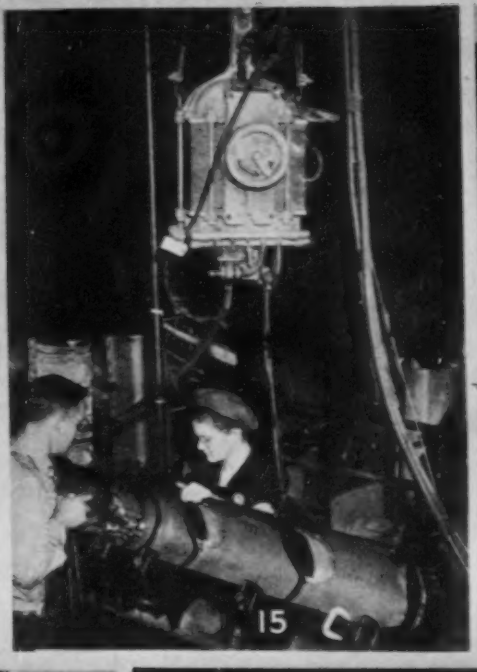
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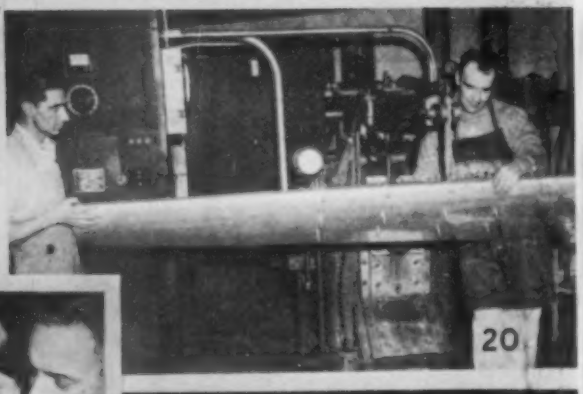
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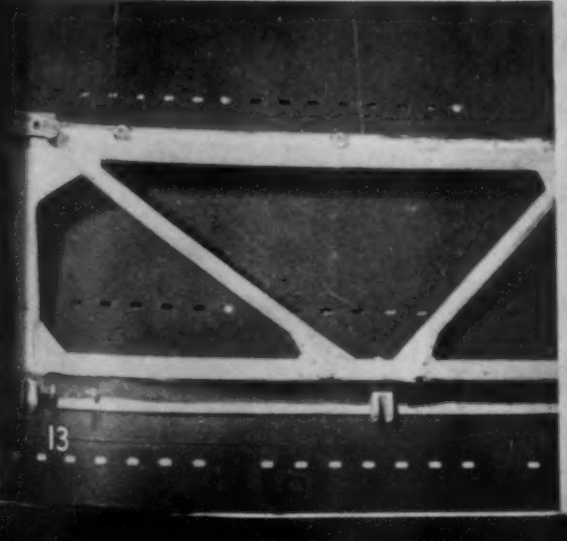
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Each jig is mounted on a horizontal axis so that it may be rotated and all welding done in the down hand position. Figure 11 shows a close-up of this welding operation and shows the care with which such a jig must be designed so as to allow accessibility for the welder. Figure 12 shows the welding being completed outside the jig. Figure 13 shows a redesign of this assembly in which the various bushings and bolting faces are inserted oversize, the skid completely welded and all drilling and machining done afterward. Permissible tolerances as to distortion were determined and no straightening was required when the skid was fabricated in this manner.

Gas-Welding Applications

A considerable amount of both ferrous and non-ferrous gas welding is done in aircraft assemblies, particularly in thicknesses below approximately $^1/_{32}$ of an inch. Figure 14 shows the gas welding of an aluminum duct.

Spot Welding

Stainless Steel

A considerable amount of stainless steel is used in the construction of an airplane, particularly around the exhaust system. These stainless steel assemblies are almost entirely spot welded since stainless steel lends itself so admirably to this process. Figure 15 shows a stainless steel shroud being tack welded by means of a push gun and backing shoe. In this figure the shroud has been assembled in the jig with the insert plates and lap joints ready for tacking. The male operator is shown using the push gun, the female operator holding the backing bar or shoe against the outside of the shroud. The push gun has a calibrated spring so that the firing circuit cannot be closed until a predetermined pressure has been exerted by the operator. A close-up of this operation is shown in Fig. 16. The tack-welded shroud is shown in Fig. 17 ready for spot welding in a rocker arm welder. This procedure of tacking and then welding results in maximum speed of assembly. Figure 18 shows the shroud being spot welded.

Aluminum

Figure 19 shows a row of stored energy type aluminum spot welders. On these welders a wide variety of aluminum assemblies are spot welded. A prerequisite to the spot welding of aluminum is the removal of the oxide film existing on its surface. For this purpose a variety of methods may be used depending on individual conditions. A number of papers have been published in recent years tending to show that a low interface resistance is necessary for optimum welding conditions, a generally accepted value being from 10 to 50 microhms. Recent experiments have indicated that satisfactory welds may be made with the interface resistance many times the values given above, and it may be that too much time has been spent on refinement in cleaning methods whereas adequate cleaning necessary to meet minimum designed spot-weld strength values coupled with the cleaning of a number of parts in assembled form would have resulted in increased production with adequate welds. Figure 20 shows a leading edge being spot welded in a rocker arm type machine. Figures 21 and 22 show the primary cowl section being welded and give some indication of the comparatively large assemblies being welded at the present time. In addition to the assemblies shown in these figures a large number of sections in the airplane may be spot welded and the present tendency is toward a greater percentage of spot welds and a decrease in the number of rivets. This tendency is given added impetus by the ratio of approximately 1 to 10 in the cost in favor of the spot weld.

Figure 23 shows a group of P-47's in flight and is representative of the fine aircraft being constructed today in the United States (cover picture).

The writer desires to extend his appreciation to the management and his co-workers at Republic Aviation Corporation for their cooperation in the day-to-day applications of welding to aircraft structures.

Welding Procedures Used to Complete "Big Inch" in Record-Breaking Time

By J. R. Morrill*

THE accompanying photographs show interesting welding operations used in constructing the "Big Inch," largest oil line ever built.

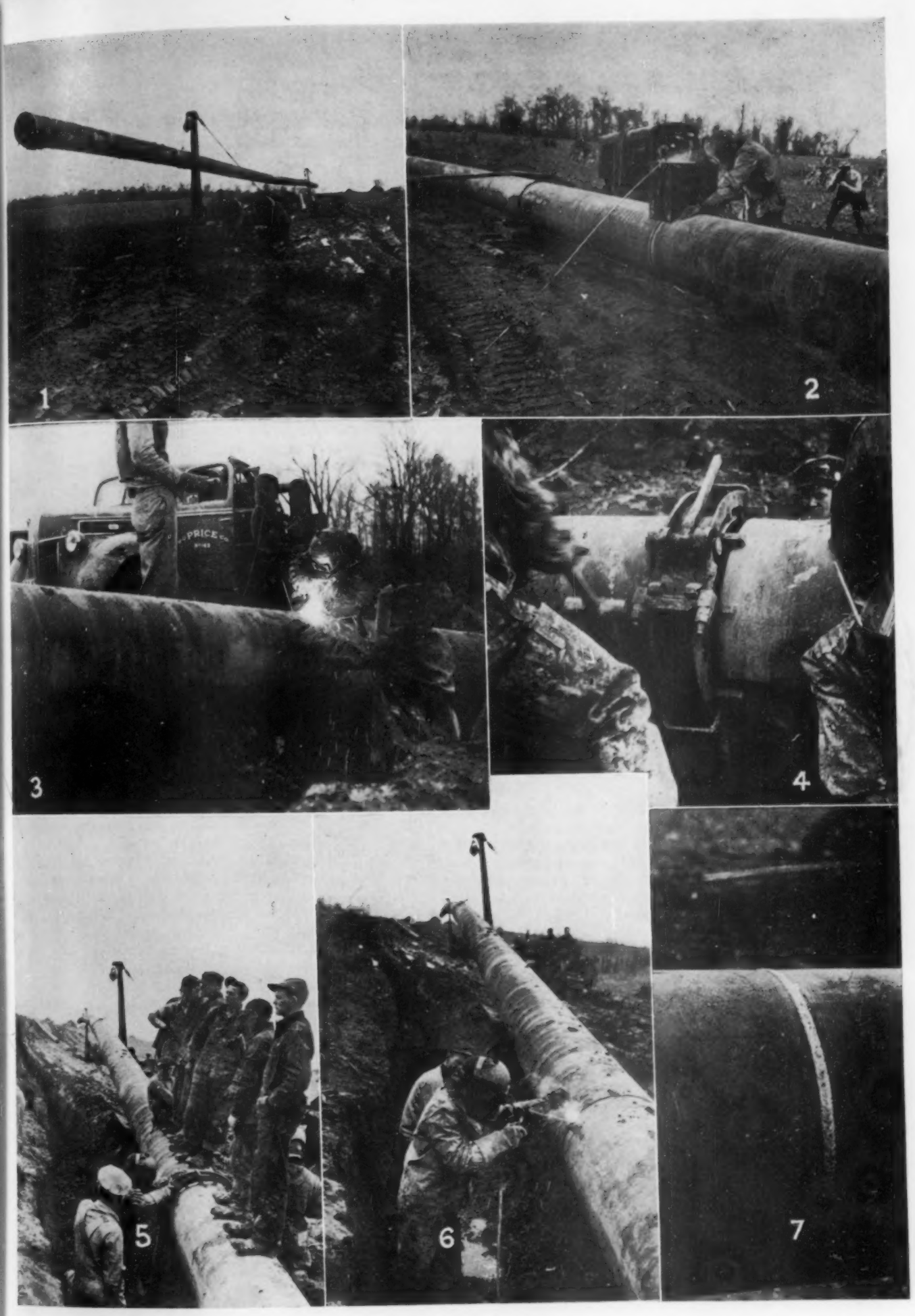
They show some of the techniques used in speeding up construction through the muddy terrain encountered.

* Assistant to the Vice-President, The Lincoln Electric Co., Cleveland, O.

The line, which has a capacity of 300,000 barrels of oil per day and is made of 24-in. seamless pipe of $^3/_8$-in. wall thickness, runs from Longview, Texas, to Norris City, Ill., and is being extended to the Atlantic seaboard.

Figure 1 shows two tractors carrying a section of the line—total length 150 ft.—to the end of the line for lining up and welding. Figure 2 illustrates firing line welder putting in the last pass of a roll weld. The wing guard shown protects the arc and facilitates welding. In Fig. 3 bell hole welders complete the tie-in weld.

Figure 4 shows the lining up and clamping of a section of pipe to the end of the line. The bar wedges are hammered into place, bringing the bevelled ends of the pipe together. In Fig. 5 men of the tying-in crew stand on the ends of the pipe to help bring them in line. The welders are here tacking the joint after it has been properly lined up and clamped. Figure 6 shows another view of bell hole welders showing length of pipe suspended during welding operations. Figure 7 illustrates completed roll weld.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Welding Wrought Iron, High Carbon Steel and Cast Steel

By H. R. Morrison*

MANY pages in trade papers generally, as well as many special booklets, have been devoted to the proper procedures for welding the more common ferrous metals, such as mild steel and cast iron.

Wrought iron, high carbon steel and cast steel have received less attention; yet all are in common daily use, and welding plays an important part in the reclamation and upkeep of equipment made from these metals. Welding operators employed in the plants producing these metals or equipment fabricated wholly or in part from them are naturally familiar with the special welding technique necessary for attaining good results. But the operator in the outside contact or general welding shop has less occasion to work with equipment made from such metals.

Identify the Metal

The operator should learn the identity of the metal on which he is to work before he even lights his blowpipe. The easiest, quickest and most satisfactory way to do this is to get this information from the manufacturer (or his agent) of the part or from the concern for whom the repair is to be made. If the information is not readily available from these sources or is not very satisfactory, then the operator should know how to find out for himself, by simple tests, into what class the metal falls. The spark test, the chip test and the blowpipe test will usually establish the identity of an unknown metal.

Another clue, sometimes quite sufficient, is provided by the part itself. Wrought iron, for example, is used extensively in manufacturing pipe; but at the same time much steel is also manufactured into tubular goods, so this in itself may not always be a very helpful indication. The service for which the pipe was or is to be used may furnish a clue. It is helpful to know that shear blades, cutlery, dies, tools and automobile springs, while made of steel, are not made of soft steel. A soft or mild steel, such as that used in plate or structural shapes, is low carbon, but hard steels, such as those used in shear blades and the like, are usually high carbon or high carbon alloy steels. Then, there is a range of plain carbon steels, known as medium carbon, containing from 0.35 to 0.50% carbon, which are hardenable steels, as well as that range of complex steels known as high-alloy or low-alloy steels. Since the beginning of the war, steels known as "National Emergency" steels have come into use. All these several special steels, from a welding technique standpoint, can best be handled as though all were high carbon steel.

Finally, the average steel casting, by shape and use, tells much of its story. Parts of digging equipment, since they have to stand great shock and repeated stresses, are unlikely to be made of cast iron, for this metal cannot be expected to withstand the fatigue and abuse such equipment gets. A steel casting that is under hydrostatic or air pressure in service may sometimes show leakage, and outwardly such a casting may have little to distinguish it from cast iron. If, however, you know the use to which the casting has been put or will take steps to find out, you will be in a far better position to perform a satisfactory welding job on it.

The following brief account of correct welding procedure will probably be a helpful reference guide in reclaiming equipment made from these types of ferrous metals that come infrequently to the average welding shop.

Preparation of Any Metal for Welding

The mechanical operations of preparing the vee for welding and controlling the welding puddle do not vary greatly with different base metals, but that does not mean that the whole procedure is the same. A welding vee completely filled with welding rod fused to the base metal does not necessarily mean a successful weld. While some base metals possess considerable ductility, others are brittle and require preheating of the whole part to make welding successful. Some metals require considerable agitation of the molten puddle, while others must be welded with as little disturbance as possible. All of these factors, such as preheating, flame adjustment, flame size, amount of puddling required, and postheating, are a part of a welding procedure. With the technique for welding mild steel mastered, the operator should find little difficulty in learning to make successful welds in other base metals, provided he understands the importance of the differences in physical properties and what steps should be taken to overcome the effects of these varied properties.

In this article, the important differences between ordinary steel and wrought iron, high carbon steel and cast steel will be pointed out and the necessary variations in welding procedures described. Practice exercises will not be given since the physical form of the base metal has an important effect on the welding technique in many cases.

Wrought Iron

Wrought iron consists essentially of a mechanical mixture of high-purity iron and a slag of iron oxides and silicates. This is quite different from other commercial irons and steels that are alloys of iron and other elements. The slag in wrought iron is uniformly distributed through-

* The Linde Air Products Co., New York, N. Y.

Fig. 1

A wrought-iron weld requires considerably more heat than a steel weld, because of the high melting point.

out the pure iron in the form of very small particles which, by rolling, are stretched out into threads or fibers, so small that there may be as many as 250,000 or more per cross-sectional inch of finished material. The fibrous structure of wrought iron is produced by from 1 to $3\frac{1}{2}\%$ of slag and results in a material that has a tensile strength of about 45,000 psi. in the direction of rolling. Wrought iron has high ductility, good corrosion resistance and high resistance to fatigue failure.

Welding Wrought Iron

The iron base metal in wrought iron has a melting point of about 2750° F. while the slag melts at from 2100 to 2200° F. Two characteristics of importance to the welding operator result from these melting points. The first is that wrought iron will stand and, in fact, requires more heat in welding than is the case with ordinary steel because of the high melting point. As a wrought iron part is heated in preparation for fusion welding, the slag will melt first resulting in a greasy appearance of the surface of the vee. With most base metals, this greasy appearance is a signal that the base metal is ready for fusion with the welding rod, but in the case of wrought iron that is not true, and more heat must be applied until the base metal really begins to melt.

Wrought iron can be easily welded by the oxyacetylene process, using somewhat the same procedure as is used for soft steel. The best welds are made, however, when the intermingling of the base metal and welding rod metal is not excessive. Welding is accomplished with a neutral flame and a welding rod that has neither high carbon nor high-alloy additions.

High-test steel welding rod is recommended for welding wrought iron. The welding operation consists of first concentrating the flame somewhat more on the end of the welding rod to build up a puddle of molten metal and then concentrating the flame on the base metal surrounding the puddle and fusing the molten puddle with the base metal. Welding should be accomplished with as little agitation or puddling of the molten metal with the welding rod as possible.

Wrought iron plate or pipe $\frac{1}{2}$ in. or more in thickness should be welded by making more than one pass. A technique using backhand welding with a flame having slight excess of acetylene is recommended for welding all-wrought iron piping. The steps to be taken to counteract the effects of expansion and contraction are the same as those for ordinary low carbon steel.

High Carbon Steel

From the standpoint of oxyacetylene welding, steel containing over 0.70% carbon is considered high carbon. This includes the high carbon machine steels, spring, cutlery and nearly all common tool steels. Although such steels can be welded successfully, it is important to obtain a thorough knowledge of their properties and correct heat treatment, as well as to have available the necessary shop equipment for the heat-treatment required, before welding is attempted.

Most metal parts that are manufactured from high carbon steels have certain properties that are developed by means of a special heat treatment. As with any heat-treated part, when the temperature of the base metal is raised to the temperature required for welding, the special properties are more or less destroyed in the neighborhood of the weld. Although these properties usually can be restored by the proper heat treatment after welding, provided the proper rod metal was used, it is quite often a complicated procedure beyond the scope of many welding shops. If a metal part of high carbon steel has failed during normal service, it is obvious that a repair weld must be capable of developing at least as good strength properties as the original part or it will immediately fail again. This factor should receive serious consideration when the part is of such importance that its failure in service would create a definite hazard.

When high-carbon steel parts are to be welded, it is usually desirable to preheat them. Welding should be done with an excess acetylene flame and the operator should use just enough heat to obtain fusion between the weld metal and base metal and thus avoid overheating the base metal.

The choice of welding rod for joining high carbon steel parts depends upon the circumstances. For relatively thin parts where considerable intermingling of base metal and weld metal will occur, a relatively low carbon welding rod with certain alloy additions to improve its strength properties can be used. For heavier sections or for parts which are to be subsequently heat treated for increased hardness and strength, a higher carbon rod, such as chrome molybdenum steel rod, is recommended.

Cast Steel

The term "cast steel" is applied only to those parts which are formed by pouring molten steel into a suitable mold such that the solidified metal will be the desired part without any subsequent forming operation being required, except possibly the machine-finishing of certain surfaces. In this respect, it is like cast iron, but there the close similarity ends. Cast steel has high strength, good shock resistance, and considerable ductility and toughness, and it is for applications requiring those prop-

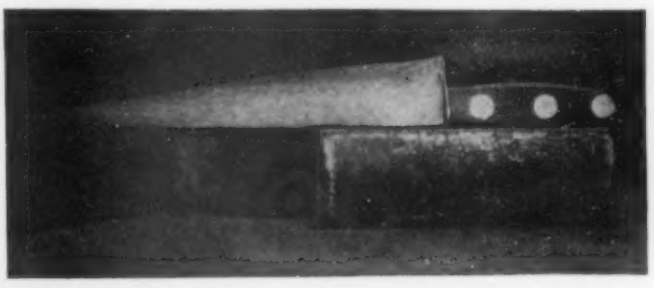


Fig. 2

In welding high carbon steel avoid overheating the base metal by using barely enough heat to obtain fusion.

erties, as well as for rather intricate shapes, that steel castings find wide use.

Cast steel can be distinguished from cast iron by its superior toughness; by the fact that a cold chisel will cut a more ductile chip; by the much finer grain structure; by its steely rather than grey color and the higher metallic luster shown on a freshly fractured surface; and also by the behavior of the metal under the blowpipe flame.

Welding steel castings is an operation that is performed both in production and in repair. In production work, a number of important advantages result from the use of a composite structure, in other words, a structure that is built up by welding together steel castings and steel-plate sections. Such structures are easily welded by using the normal steel welding procedure, though consideration must be given to the effects of expansion and contraction. These effects are often somewhat different from those encountered in normal steel welding because of the frequently greater mass and more intricate form of the steel casting, with light and heavy sections adjoining one another.

Repair work on steel castings may be either the repair of fractured parts or the filling up of holes or other defects that may occur during the casting operation.

Preparation for Welding

Because of its ductility and toughness, a good steel casting will bend considerably more before breaking than will one of cast iron. All broken steel castings, therefore, should be carefully examined for such distortion. Any heating and bending required to restore a casting to its original shape and alignment should be done before beveling and welding.

Small steel castings require no preparation other than beveling the edges to be welded and making sure that the surfaces are clean. Beveling can be done with the cutting blowpipe, a chipping hammer or by grinding. If the cutting blowpipe is used, the edges should be cleaned before welding, either by grinding or by wire brushing.

Larger castings with thick walls, or of such design that localized heat of welding might set up strains in the steel, should be preheated to a bright red temperature after beveling. Whether preheating should be general or local depends upon the design of the casting.

Welding Technique

Welding the casting, whether preheated or not, is done in a series of overlapping layers in the same manner as in welding heavy steel plate. As it is possible that the break may have resulted from a sand hole or dirty spot, watch the weld carefully for the bright spots or craters in the molten metal that are evidence of such defects and melt under these spots with the blowpipe flame and work them to the surface. Any sand or slag should be worked out to the edge of the puddle.

Where the break occurs between sections of unequal thickness, direct the heat of the blowpipe flame more toward the heavier section so that there will be no tendency to overheat the lighter part.

High-test welding rod is recommended for repairing steel castings. Welding should be done with a neutral flame.

Building Up Edges

Two special types of jobs are met frequently in work on steel castings: (1) building up lugs, bosses, gear teeth or misrun edges; and (2) filling holes. The technique for each is slightly different from the ordinary run of work on cast steel.

Building up edges and lugs affords excellent practice in the control of weld metal. As experience is gained, the operator can, by carefully manipulating welding rod and blowpipe flame, add metal very close to the desired finished shape.

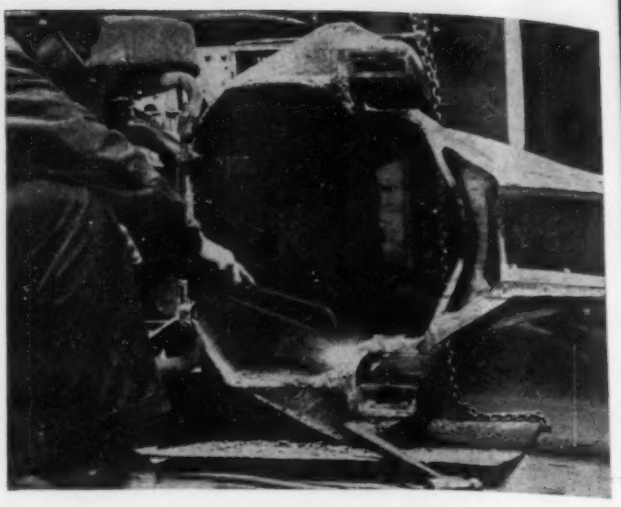


Fig. 3

In making a weld between cast-steel sections of unequal thicknesses, direct most of the heat on the heavier section.

In building up a lug, be careful to get thorough fusion of the weld metal with the base metal as the first layer is applied. Then as a molten pool is formed, add welding rod to the pool. Control the molten metal at the edge by drawing the flame back a bit if the metal appears to become too fluid. You will soon learn to direct the flame in such a way that the weld metal is readily controlled. When working at the edge, you can control the metal more easily if the blowpipe flame is held slanting upward and inward toward the center of the lug. Build up just a little more than the finished dimensions so that the part can be dressed to a smooth surface.

Filling Holes

In welding up a hole that extends all the way through a piece of steel, it is best to countersink the hole first or to fuse down the sides of the whole so as to get the same result as a countersink. Then start welding at the bottom edge and add weld metal all around in progressively narrowing circles until the hole is closed at the bottom. Continue to add metal a layer at a time until the hole is filled. Fuse each layer thoroughly to the one below and to the sides of the hole.

Where the hole extends through a thick section, it is advisable to countersink from both sides. Fit a piece of $^1/_8$-in. steel plate in the hole at the smallest part where the countersinks meet. With this plate acting as a bottom piece, fill up the hole from one side as just described. Turn the piece over and complete the filling operation from the other side. Be sure to fuse the plate thoroughly with the sides of the hole and the added weld metal.

A depression is filled in the same way. Be sure that the bottom and sides are fused thoroughly before adding weld metal.

When any welding on steel castings in a preheating furnace is finished, cover the castings thoroughly with asbestos paper or other insulating material to retain the heat, and then let the fire die out. Allow the casting to remain covered until cold. Be sure it is not exposed to any drafts.

Where castings are not preheated, the weld area should also be protected with heat-insulating material and allowed to come to room temperature gradually. In a steel foundry, all reclamation welding should be done after the casting is cleaned but before it is annealed.

Plant Weldery*

By Louis H. Burr†

DURING the early years of the company the officers saw the advantage of having a structural shop to furnish as much as possible of the steel required in the construction of the buildings which they contracted to design and build. This shop was built along the lines of a modern structural shop for fabricating steel by the riveted process of making all connections and was very successful in turning out large tonnages of the riveted steel buildings.

Having their own shop they could control the product both as to time of delivery and the method to be used in shop fabricating which, due to the progressiveness of the officers, was the very latest and approved method available. Very early these men started the study of fabricating structural steel by the use of the electric arc. This study convinced them that the method was practical and being modern had a sales feature of which they were quick to take full advantage.

For some years the riveted method of fabrication was used along with the welding but the disadvantages of using two methods in the same shop became very apparent and within the past year it was decided to do only welded fabrication in the shop. The advantages from welding were many. A modern method of constructing a building was a great sales point to the prospective buyer and that in itself sold many buildings.

Using new sections for roof trusses such as tees made by splitting wide flange beams for cord and web members eliminated the use of plates in the fabrication as the web members were slotted so as to fit over the webs of the chords and then electrically welded to them in the shop. This elimination of plates reduced the weight of the trusses from 15 to 20% and the saving in weight spread over an entire building would reduce the total cost of the building. An illustration of this saving is as follows: A building of about 3500 tons has 279 trusses which weigh 350 tons. By using welded construction a saving of about 16% can be made on these trusses which amounts to 60 tons of steel. This would be about $6000 for the steel based on a price of $100 per ton F.O.B. shop for the total steel used in the building which would reduce the total cost and could make the builder low on his bid. In addition to this saving if rivets had been used it would have required about 1% of the weight for the shop rivets or 35 tons at $0.04 per lb. or $2800 as against 6 lb. per ton for welding rod or about 9 tons at $0.065 per lb., or $1125. This is a saving of $1675 in the cost of the structural steel which could be the difference between profit and loss to the fabricator. This makes a total saving on the structural steel for the building of $7675. Based on a price of $100 per ton for structural steel F.O.B. shop the total price of this building steel would be as follows:

Riveted—3586 tons at $100	$358,600
Welded—3500 tons at $100	350,000
Total savings, or 2.4%	$ 8,600

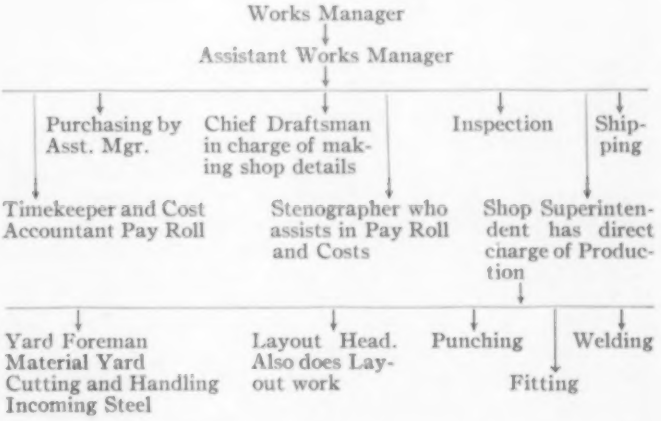
Our shop produces 14,000 tons per year and if it would all be in the same proportion the savings would amount to approximately $35,000 per year based on the price per ton mentioned; however, this price varies with different conditions.

This savings multiplied by the total tonnage in one year is sufficient to eventually force the entire industry to adopt welding as the best method for fabricating structural steel.

The eliminating of holes and time saved in punching, layout and fitting is offset by the extra cost of the welding operation and cleaning of the steel before painting so that the shop cost per ton is about the same as that for a welded structure.

In an emergency like the present when plates are needed so badly for ships the elimination of all plates used in the trusses due to welding is an item worth serious consideration.

The organization of the plant weldery should be as simple as possible so as to save on the overhead expense. The men chosen for key positions should thoroughly believe in welding as the best method for fabricating structural steel and also be able to sell the idea to the men who are working under them. A very simple organization is as follows:


Works Manager
Assistant Works Manager
Purchasing by Asst. Mgr.
Chief Draftsman in charge of making shop details
Inspection
Shipping
Timekeeper and Cost Accountant Pay Roll
Stenographer who assists in Pay Roll and Costs
Shop Superintendent has direct charge of Production
Yard Foreman Material Yard Cutting and Handling Incoming Steel
Layout Head. Also does Layout work
Punching
Welding
Fitting

The general accounting will be done at the main office of the company as will also the general work of purchasing. Specifying of items for purchase will be done by the plant weldery.

The designing of the building will be done entirely by the general engineering department when they are designing the complete building.

These plans are then sent to the weldery where the shop details are made by engineers who specialize in structural shop welded details. These men have been trained

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† Works Manager, The Austin Company, Fabricating Division, Euclid, Ohio.

in this line of work and are experts. They must study the job and then set up details for economical as well as practical shop and field connections. They must know what is the simplest and most practical method of making the connections in the shop so that the work can quickly be put together in the field. We have been welding steel for buildings since 1929 and these men have carefully studied the various forms and methods of connections so that now a job can be welded at approximately the same cost both in the shop and the field.

Complete information is placed on the shop detail drawings and all information is given to the shop so that they can fabricate the steel and know that the building will go together in the field if they follow the measurements on the plans. Every weld is shown on these drawings which give the location, the size of bead and the length required to give the strength necessary to carry the loads which will, by various conditions, be placed upon the steel when the building is completed. No deviations from the detail drawings are allowed and consequently no guess work is left to the shop or field welder. A field welding diagram is also made for the use of the erector in field welding.

A very simple method is set up for keeping costs on all jobs. Each job when received is given a contract number and that number is shown on the drawing. Each man is checked during the day so that his time is applied to the correct job on which he has worked whether a full day on one job or several jobs. The next morning the cost for the previous day is figured from the pay roll and the amount applied on a card for the particular job which shows the total to date and thus a comparison can be made with the estimate to allow special effort to be placed on that job to keep the cost within that estimate. A list of pieces which have been completed during the day is made as they come out of the shop and the weight figure so that the average daily cost can always be known early the following day. This is very important as it shows quickly whether the shop is performing efficiently. The cost of various operations can also be kept by the man checking the time as he can note the shop order and the operation on which each man is working, for example:

Check No. 20 Shop Order 2700—Layout, 8 hr.
Check No. 24 Shop Order 2700—Fitting, 8 hr.
Check No. 30 Shop Order 2700—Welding, 8 hr.

This is also a help as it shows which operation may be slowing up a little and the cause found and a remedy offered to bring it up to standard.

The selection of the right type of man for welding is a very important consideration for the weldery either just beginning the use of arc welding or in increasing the amount of welding which is being done. At the start we picked five men who had been with the company for several years and sent them to a welding school. After their training they returned to the shop and were so enthusiastic about the work it was not difficult to find others who were anxious to take up the operation. Of the five first trained four are still with the company, one of whom is now welding inspector.

When a man shows interest enough to want to try welding he is placed in the fitting gang and does all the tack welding of the material before it is sent to the welding floor for completion. After he has become accustomed to handling the arc he is allowed time either during working hours or after to work on scrap material making beads and welding pieces together under the supervision of one of the regular welders. He thus learns welding and when there is a need for an additional welder he is put on the floor with one of the welders and classed as a junior welder. He only works on the lighter material for a period of several months during which time he is frequently tested with bend brake pieces and pulling tests to show his progress. He is passed as a first class welder as soon as he passes the A.W.S. Test for Structural Welders. With this method we always have welders of our own and it is rarely necessary to hire a man who is not acquainted with our style of work.

The inspector must continually check the welding which is being done. He must be sure that the correct heat is used for the size of rod and the proper procedure is being followed. He must mark the size and length of the bead at all points where weld is required and at the completion of fabrication he must check the welds to know that all welds are in accordance with the detail drawings.

In changing to a weldery it was necessary to secure some new equipment and make changes in others so as to secure the greatest efficiency possible. It was found that one punch was idle most of the time so an attachment was developed to split short beams and make the tees necessary for the diagonal members for the trusses and the tees about 20 ft. long for struts and bracing members between columns and trusses.

In order to split the long beams for the chords of trusses an automatic burning outfit was made so that the driving wheel and the guide wheel rode on the flanges of the beams with the torch in the center to do the burning and the motor to do the driving at a maintained speed. These tees were bowed by the heat of the torch so a bull riveter was rigged with dies and used for straightening of these members.

As there were no assembly holes in the members for bolting together the pieces in the fitting, the skids on the assembly floor were bolted to the concrete floor and an angle welded along the ends to make a fixed grid. The top flanges of the beams and the outstanding legs of the angles were punched, with the holes about 2 in. apart.

The beams which held the weight of the members to be assembled were about 8 ft. apart and between these were placed loose angles with the outstanding leg punched and these could then be adjusted any place between the beams to fit the requirements of the pieces to be assembled. On this grid a jig was set in a short time to provide for the complete assembly of any trusses, bracing and miscellaneous pieces. While these pieces are in the jig they are tack welded together and then taken out to the welding floor for finishing and the assembly of other material proceeds without any delay The welders do not have to move their cable and electrodes to the work and much lost time is avoided and in this operation it is important because the final production for the day depends entirely on the amount of material which is being welded complete.

A sufficient number of C clamps of various sizes must be provided on the assembly floor as care must be taken that the pieces fit closely together before tacking and welding and this is best accomplished by squeezing them with the clamps while being tack welded.

A larger floor space is required to efficiently carry on a welding program and a truss shop was added so that all trusses could be assembled and welded in this building and not interfere with the columns and miscellaneous steel. In this way all steel for a building can be worked out together and shipment made more promptly.

After welding, all the welds must be carefully cleaned of slag and flat scrapers can be made for this work to be followed by a wire brush and an air line to blow off the loose dirt before painting.

When the steel is painted it is loaded into cars and is ready for the field where the erection is carried on quickly by means of a few holes in the connections to allow bolting together and plumbing before the field welding is

done which completes the operation as far as the steel structure is concerned.

Electric welding of structural steel is certain to develop very fast in the next few years because:

1. The cost of the operation can be made to equal that for riveted work.
2. A considerable saving can be made in the total amount of steel required for a building.
3. The structure is much more rigid than the old riveted style of work since an 80-ft. truss can be raised for erection with a single chain at the center panel.
4. By actual tests the weld used to equal a $^3/_4$-in. rivet will carry more load than the rivet and there is not the danger of cracked metal which appears at the hole when a riveted connection is overstressed.
5. A strong sales point is made in the fact that the building is the most modern construction possible.
6. Various new developments can be made in the style of architecture which are not easily done with the riveted process, for example: The Rigid Frame which allows more light on the interior without the resultant shadows that often develop in other types of construction

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Tool Salvaging by Low-Temperature Joining*

By Bent Laune†

THAT we, as a nation, have been a wasteful people, is a fact that cannot be denied. That this is true, is not so much an indictment of our manner of living, as it is a natural consequence of our being accustomed to all the comforts and necessities, not to say luxuries, that have been so easily available to us, through our mass production methods and natural resources and high standard of living.

It has been so easy in the past to discard and replace that which has become slightly worn but has not outlived its usefulness, to buy a new article instead of repairing a broken one, to waste food. Thus it is not surprising that our personal wasteful habits have been carried into industry also. Here, too, there has been in the past, a most appalling wastefulness of materials, machines, parts and tools. And the last is not the least of these.

However, waste in industry, the scrapping of finished and semi-finished parts has often been just a plain matter of dollars and cents. It has actually been cheaper in many cases to replace an article or tool, than to repair or reclaim it. Or, at least, so we thought.

Today, however, how different the picture. Now we find ourselves engaged in a global war, and faced with the necessity of furnishing food, clothing, machinery, munitions, weapons and all manner of supplies, not only to our own vastly expanded armed forces but to our allies as well. We are finding out, that great though our resources are, we can suffer from shortages. We find ourselves rationed on rubber, on gasoline, on fuel oils, on shoes and now on food. Important metals and facilities are allocated by the Government. All of this we can, and will, bear gladly, in order that our paramount aim be accomplished, winning this war.

Many lessons have been learned as to how to use substitute materials, how to prolong the life of tools and machines, how to produce two units where one has been produced before and in this vast war production, cutting tools play a major role indeed.

Made of critical materials, being naturally expendable, and the need for them being multiplied many times, cutting tools of all types are one of our most serious bottlenecks. Heroic though the combined efforts of the manufacturers and the tool room have been, they are still difficult to obtain and thus production is often threatened, sometimes vitally. Instances can be cited where the lack of a single tool, a broach or a reamer or an end boring mill has held up a whole production line. Today the repair and salvage of such worm and broken tools occupied a large proportion of the thoughts and time of an ever-increasing number of the producers of our war goods.

Fortunate indeed, it is then, that in recent years materials and processes have been developed, whereby broken tools may be quickly and easily repaired, whereby new tools may be made by the utilization of scrap high-speed steel either in whole or in part, whereby tools may be tipped with high-speed steel, with stellite or with tungsten carbide, all of this being accomplished at low temperatures, with no subsequent rehardening required, which brings us to our subject matter, Tool Salvage by Low-Temperature Joining.

Attempts have been made to salvage tools by using all of the processes known, such as metallic arc welding, atomic hydrogen welding, oxyacetylene welding. In all cases the temperatures involved are high, as a fusion of the parent metal is required. The heat treatment is spoiled and the welded tool has to be heat treated again. The welds require after-machining and special tools. These processes can only be used if specialized welders are available.

The process which we would like to present in this paper is a new one where heat-treated steel is joined to heat-treated steel at such low temperatures that the heat treatment is not affected. The unusual part of it, besides the factor of low temperature, is that the tensile strength results obtained are very high; for example, as high as 117,000 lb. on a loose fit and from 140,000 to 150,000 lb. on a tight-fitting joint.

This new process, known as the Castolin Eutectic Process, is now used in many of the largest plants throughout the United States, and the reason for its fast-increasing popularity is that it is a simpler than the fusion process and permits to obtain highly satisfactory results with a minimum amount of skill and study. The process is a development of a Swiss welding engineer and metallurgist, Mr. R. D. Wasserman. This development employs such low temperatures, and the weld is completed

* Presented at Feb. 17th Meeting, Pittsburgh Section, A.W.S.
† Eutectic Welding Alloys Co., New York, N. Y.

so rapidly, that distortion of the metal and change of structure are avoided.

We would like to explain at this step that this process utilizes the phenomenon of eutectic fusion between certain base metals and alloys. (The word "Eutectic" means easily melted—of maximum fusibility—said of an alloy or solution having the lowest melting point possible with a given component.) The alloys and base metals develop a strong affinity for each other, even though the melting point of the applied metal is far below that of the parent metal.

In addition to the low-temperature factor in this process of welding, there is the element of speed. By this process a weld is produced so rapidly that a dangerous temperature is not reached. There are accordingly less distortion and no change in the metallic structure to weaken the metal in the molten zone.

Another point worthy of note is the color match possible for various metals through the selection of the proper rod. For example, welds on aluminum, brass, phosphorate bronze, nickel, silver, monel and steel are accomplished with perfect matches.

This process of welding, it can also be pointed out, differs from brazing in that alloys, quite similar to the parent metal, are applied although the technique is like brazing. The weld, accordingly, has physical properties closely matching those of the parent metal, and in many instances the joint is stronger than the body of the welded metal.

Besides salvaging of tools, the process is used in the production of tools. It also is applicable to cast-iron welding, steel, armor plate, malleable iron, stainless steel, non-ferrous metals such as brass, bronze, copper, nickel, monel, and to aluminum and magnesium.

The process for tool salvage employs specially developed alloys which bind on the parent metal without fusion at moderate temperature like 1300° F., and 950° to 1050° F., for example. The process by itself could be classified as a braze except for its much greater field of application, which is due to the high physical properties obtained.

The manufacturer of the eutectic alloys produces 42 different alloys which are used either with a torch, metallic-arc, in furnaces, etc.

It is our purpose to discuss some of the ways and means of making these repairs, describe some typical applications and give details of the alloys suitable for this important work.

First, it is important to recognize that the greatest benefits are to be derived from this process, by establishing a tool repair center, placing all work of this nature in the hands of 1, 2 or more operators, however many may be necessary to handle the volume of work in a given plant. These men soon acquire a skill and facility and the ability to use the brazing alloys at their proper temperatures, which is highly important as the operations are conducted at temperatures close to the point at which tools will lose their hardness. They also become highly skilled in devising alignment fixtures. The work requires patience and close attention to detail, but it is a well-established fact that it not only will keep tools in use, but there are actual monetary savings, amounting in the case of one large user to some 14% of the total cost of all tools, over the period of 1 yr. Individual savings may run as high as 50% on some tools. This, of course, is incidental as the primary object is to keep the tools in production. That is the only true measure of cost, or rather the lack of the tools could be—a cost measured in the lives and security of our fighting men, because a gun or a tank or a bomber arrived 24 hr. late. Let there be no absentee tools in our war production plants.

The materials and equipment required are important but not great in number. The essentials are grinders, wire brushes, emery cloth, carbon tetrachloride, soft bristle brushes, fixtures, and clamps for alignment, steel plates, evenly surfaced for use in repairing slitting saws and flat milling cutters, etc., the brazing alloys with their proper fluxes and ordinary oxyacetylene welding equipment, with single and double flame torches and various size tips. In some cases sand-blasting equipment can be used with excellent results, since the alloys referred to here will flow and bind on surfaces thus prepared. It is especially useful in the removal of brazing material that may have failed because of slippage when making the union and may have become oxidized or inadvertently overheated. The fixtures are usually devised as the different types of tools come into the salvage center. They may range from simple V-blocks cut away at the center so the flame can be applied to all sides of the joint, to elaborate spring tension fixtures with positioning screws and plates to take care of tapers. They may be either horizontal or vertical.

Of great importance are the welding rods used in tool salvage. Many of the new eutectic alloys have been tested for tool salvage, and the results have shown that these new alloys will obtain, at low temperatures, a higher tensile strength than that obtainable with ordinary brazing materials.

The eutectic alloy Nos. 16 and 1800, having a binding temperature of 1300° F. and 940° F., respectively, combine high strength with a great ability to flow by capillary attraction in any direction through tight-fitting joints. If there is a loose fit the joint still will have a very high tensile strength. Alloy No. 185, having a binding temperature of 1000–1200° F., does not have the same penetrating qualities and is most often used to fill in holes, to build up such tools as broken dovetails and tangs and sometimes to fill in chamfered joints. It has excellent wearing properties and a Brinell hardness of 180 to 220. It machines readily. It is not obviously, for cutting edges.

Alloy No. 16 develops tensile strengths averaging 117,000 p.s.i. and Alloy No. 1800, 53,000 p.s.i. In actual practice both of them have often shown much higher results. By "binding temperature" is meant, that with the parent metal, in this case the tool, heated (locally only) to the indicated temperature, the alloy, then melted down with the torch, will flow and bind on that heated surface. The alloys themselves have higher melting points, but that is of no importance in torch work, since the tool itself is only heated to the binding temperature. More about that later.

Of equal importance are the fluxes used with these alloys. They are known as "Autochemic Flux" and each alloy has its own flux in paste form and always bearing the same number as the alloy. Thus Alloy No. 16 requires the use of No. 16 Autochemic Flux. In addition to serving the usual functions of a flux, each flux has a melting point, coinciding with the binding temperature of its companion alloy. It becomes fluid when the proper temperature for applying the alloy has been reached and thus serves as a temperature index. Nowhere is this more important than when working with high-speed tools, since it avoids overheating, a feature that will instantly be recognized.

The alloys are adapted to other media of heating such as carbon arc, atomic hydrogen, furnaces, either oxidizing or reducing atmosphere, salt bath, resistance welders, high-frequency induction, etc. Used by other than torch or carbon arc or atomic hydrogen, however, higher temperatures are required, 1800° F. and above for the Alloy No. 16 and 1200° F., for the Alloy No. 1800. This renders them unsuitable for use on high-speed steel

in furnace operation, but very satisfactory when joining tungsten carbide tips to carbon and alloy steel shanks. Also, with its ability to withstand higher temperatures, the Alloy No. 16 has been successfully used in brazing and hardening high-speed steel simultaneously at 2300° F. This, however, must be done in a reducing atmosphere.

These alloys are furnished in the form of rods and, for preplacing purposes, may also be had in powder form and the Alloy No. 1800 is also made in strips down to 0.003 in. thick.

Cutting tools repaired by these methods may be depended upon to deliver full service often outlasting new tools and to the limit of their usability, standing grind after grind until there is insufficient stock left for further reduction. To give an example or two: one of the major aircraft producers repaired an expensive broach which had broken on its fourth operation. Since it was repaired, it had performed 15,000 operations up to the time last reported upon, several weeks ago. Another producer of heavy machinery has a large number of broaches, drills, reamers and cutters that have been in daily operation for more than a year since they were repaired. Some of these have 2 and more breaks that have been so repaired. Numerous other instances could be cited along these same lines.

Reference was made, earlier, to monetary savings so a few examples of the cost of low-temperature joining may prove interesting. An extension reamer made of 2 worn out reamers: cost of new tool $18; cost of reclaiming $3.00. A spline broach: cost of new tool $180; cost of reclaiming $4.00. A slitting saw: cost of new saw $24; cost of reclaiming $5.00. A circular milling cutter with section broken out, repaired by grinding a section of another broken cutter to fit and brazing in place: cost of new cutter $23; cost of reclaiming $7.20.

These figures include all time and material used, including overhead, and the actual cost of the alloy used to make the joint did not in any case exceed a few cents and in many instances it can only be measured in fractional parts of one cent.

In using these alloys there are certain cardinal principles common to all of them and common to all types of tools.

First, the parts must be thoroughly clean, all grease must be removed with carbon tetrachloride, using a soft bristle brush. Scale, rust or deposits of other foreign metals may be removed by grinding, filing or sand blasting. It is preferable, except where chamfering is necessary, to join the broken pieces, as broken. Other exceptions to this rule are to grind, where it is necessary to secure proper alignment, as when making a new tool from scraps of old tools or in combination with low carbon steel. Other tools that are invariably ground are broken circular milling cutters and saws, and sometimes very large tools. This is done so that only the chamfered surface is heated, also to avoid all possibility of spoiling the hardness of the cutting edges. In these cases the chamfer is made from both sides, leaving a thin section intact in the center of the fracture and extending its full length. After careful cleaning, the proper flux for the alloy to be used is next applied, taking pains to be sure the surfaces and adjacent areas are completely covered.

Flux should be used liberally and should be added frequently.

When ready to proceed with the joining operation, the torch is adjusted using a slight acetylene excess for the Alloy No. 16 and a larger acetylene excess for Alloy No. 1800. Torch distances of from 1 to 5 in. should be maintained and the heating should proceed slowly, and carefully paying close attention to the reaction of the flux, so that the alloy, unless preplaced, can be added at the proper time.

The torch is kept in motion throughout the entire operation. Where the precoating technique is employed, usually with Alloy No. 1800, a steel rod, flattened on the end, will assist in the precoating, by heating same and rubbing into the molten alloy. In precoating, one or both surfaces may be coated, but usually it is only necessary to coat just the one surface. After precoating, the part is again fluxed, as is also the uncoated part. In making joints of this type, the uncoated part must, of course, be brought up to the equivalent temperature of the other part before placing them in position, so that when the joining is accomplished, both pieces will heat at a uniform rate. Uniform and complete heat penetration to the proper degree throughout the entire area to be joined is essential. Otherwise, flow by capillarity will not be achieved.

A safe rule to follow is to use the Alloy No. 16 in all cases where a slight local loss of hardness does not matter. Although 1300° F., its binding temperature, may be considered as rather high for high speed steel, it has been firmly established in thousands of applications.

It has been found that if a heat-treated surface is heated up rapidly to 1300° F., and this is done only for a very short time (for a few seconds, for example), the hardness of the steel will not decrease or at least not more than a few Rockwell points. This is very true since as long as a minimum cycle of time is not reached, the steel will not draw. This is true of broaches, circular milling cutters, saws and drills broken through the flutes. Moreover, the operator will develop a skill in minimizing the temperature and it will be found that in many cases it is not necessary to complete the joining to the outermost cutting edges, as in a circular milling cutter, for instance. Further, such tools as surface broaches may be chamfered from the back partially through say, $^2/_3$ to $^3/_4$ of the dimension from the flat surface to the root of the teeth. The alloy has sufficient strength to make this quite adequate.

On the other hand, where full hardness must be maintained, as in reamers, end boring mills, high speed inserts and the like, then the lower binding temperature (940° F.) alloy, No. 1800, is used. With this alloy, there is no loss of hardness, when properly used. While it does not have the strength of the No. 16, still it accomplishes the purpose admirably and tools so repaired will give service until worn out. It contains no cadmium.

Specific instructions for the various types of cutting tools are available on request.

Reclaiming Crankshafts in an Engine Lathe*

By Walter B. Meyer†

THE metallizing of crankshafts is an old and accepted application of the process. Numerous concerns equipped with proper grinding equipment, or with crankshaft turning lathes, have been doing the work for years, and with notable results. Today, however, with manufacturers curtailing the production of replacement crankshafts, the demand for repair by metallizing has exceeded the capacity of those few shops capable of handling the larger crankshafts. Moreover, the purchase of machine equipment necessary for this work is a virtual impossibility.

Such was the situation which recently confronted us. But after a considerable amount of experimentation and some expense, we finally outlined a workable procedure for rebuilding and finishing crankshafts in an engine lathe. To date our results have been satisfactory and our failures none.

Wear and Replacement Problems

Most of our work is confined to crankshafts from the larger Diesel engines manufactured by the Caterpillar Tractor Co. The sizes most frequently repaired are from the 3-, 4- and 6-cylinder engines, having usually an 8-in. stroke. These crankshafts are machined from forgings. They have $3^5/_8$-in. diam. rod bearings and $3^3/_4$-in. diam. main bearings; the bore and stroke of the engines is $5^3/_4$ x 8 in. New shafts of this type cannot at present be delivered promptly, or carried in stock, due to the scarcity of forgings. Normal wear is most extreme on the rod bearings, Fig. 1, and to a less extent on the main bearings. However, it is usually necessary to repair both. In some cases, when oil holes may be obstructed, the damage is confined to but one bearing.

* This valuable contribution to the war maintenance program won 3rd Prize—a $100 War Bond—in the first of *Metco News'* conservation contests. *Metco News* is published by Metallizing Engineering Co., Inc., Long Island City, N. Y.

† John Nooter Boiler Works Co., St. Louis, Mo.

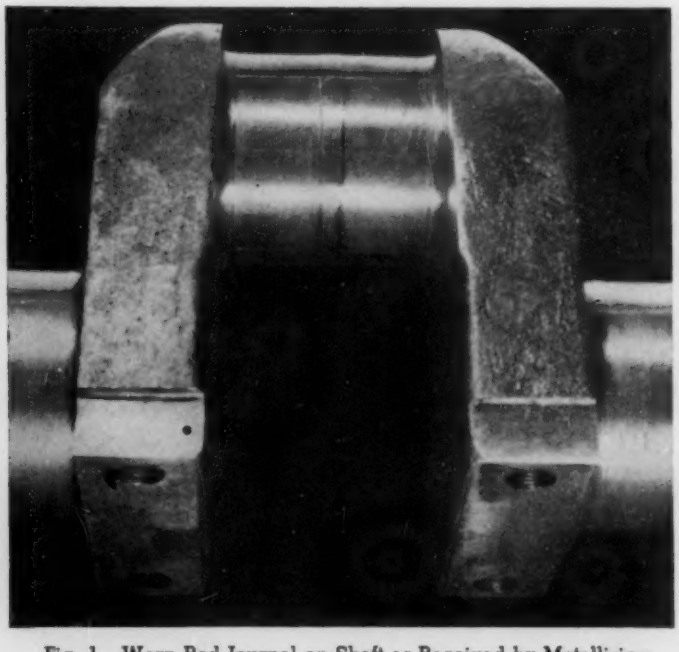


Fig. 1—Worn Rod Journal on Shaft as Received by Metallizing Shop

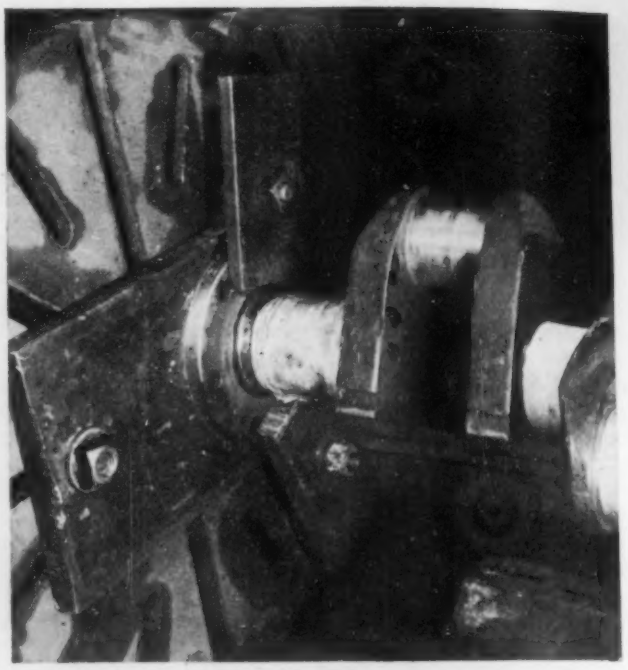


Fig. 2—Arrangement at Flange End of Crankshaft

Difficulties with Other Methods

Other than repair by metallizing or complete replacement, the most common method of effecting repairs has been to reduce the diameter of the bearings by 0.050 in. and to fit undersized bearings. This work is usually done in a crankshaft grinding machine and requires approximately one hour per bearing, at an average cost of $4.00 per bearing. This method of repair prolongs the life of the crankshaft for a period of service considerably less than that experienced from a new one. To a great extent this experience can be attributed to the removal of most of the surface hardening when the shaft is ground undersize.

In comparison to metallizing, the regrinding of crankshafts consumes far less time and costs considerably less.

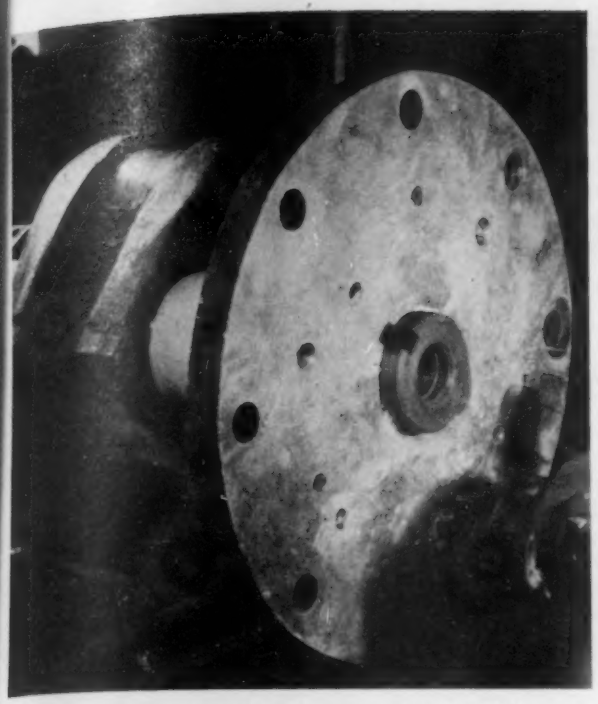
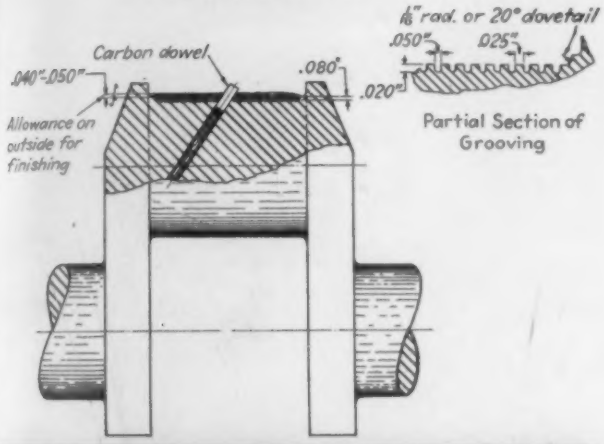


Fig. 3—Arrangement for Keying Opposite End of Shaft in Plate Mounted on Lathe Tail Stock



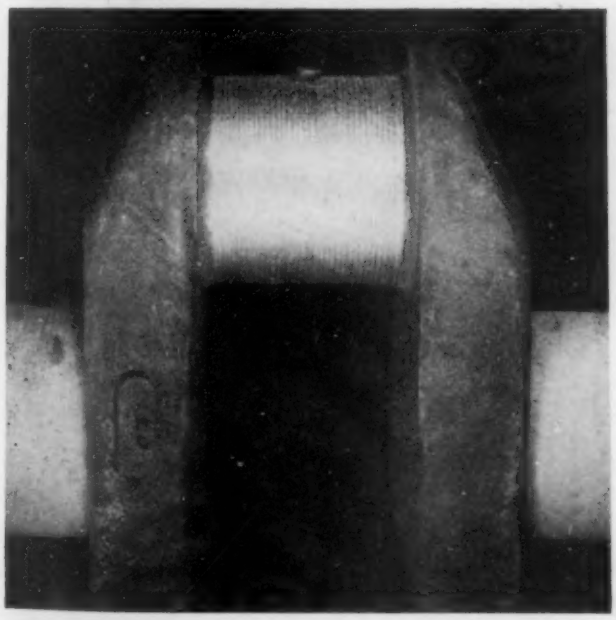


Fig. 4—Diagram Shows Dimensions of Grooves Used as Key for New Metal. Photograph Shows Journal Ready for Application of Spray Metal. Note Carbon Dowel in Place in Oil Hole

Yet there are few crankshaft grinders available that can handle the larger-sized crankshafts, and in many localities such service is simply not obtainable. Furthermore, it is often found that some of the bearings are worn more than 0.050 in. undersize and cannot be reground. It is also found that undersize bearings are often not obtainable. Finally, after a crankshaft has once been ground undersize and has again become worn, the only recourse is to metallize.

Lathe Setup for Metallizing

As received, the crankshafts usually have counterweights, stud bolts and gears removed. Our first step is to rework the crankpin bearings. To the face plate of our lathe we bolt a $1^1/_4$-in. thick steel plate, approximately 12 in. wide and 18 in. long. The area in contact with the face plate is previously faced-off lightly to provide good bearing.

Into this plate, and to a depth of $^1/_2$ in., we bore a recess slightly larger than the diameter of the flange on the flywheel end of the crankshaft, as shown in Fig. 2.

To the opposite end of the crankshaft we attach a centering flange. This flange is also made of a $1^1/_4$-in. thick plate and is 14 in. in diameter. To the center of the circular plate, and on one side only, is welded a 4-in. length, of 4-in. diam. bar.

Both the bar and the plate are bored out for a snug fit to the crankshaft, to which it is keyed. Figure 3 shows how this is accomplished.

The next step consists of setting up two steady rests, which have previously been adjusted to the bearing size. In these steady rests are gripped any two companion crankpin bearings (two rod bearings on the same angle from the main bearings). The $1^1/_4$-in. plate bolted to the face plate is then shifted until the flanged end of the crankshaft fits into the bored recess, after which it is clamped tightly, Fig. 2.

A center hole is drilled into the centering flange, and tee tail stock center, which should be a rotating center, is run into the centering flange. The steady rests are next removed and the work indicated, making whatever adjustments necessary to align the bearings. The same procedure is repeated on the next set of crankpin bearings. Two such setups will be required for the 4-cylinder crankshafts and three for the 6-cylinder shafts.

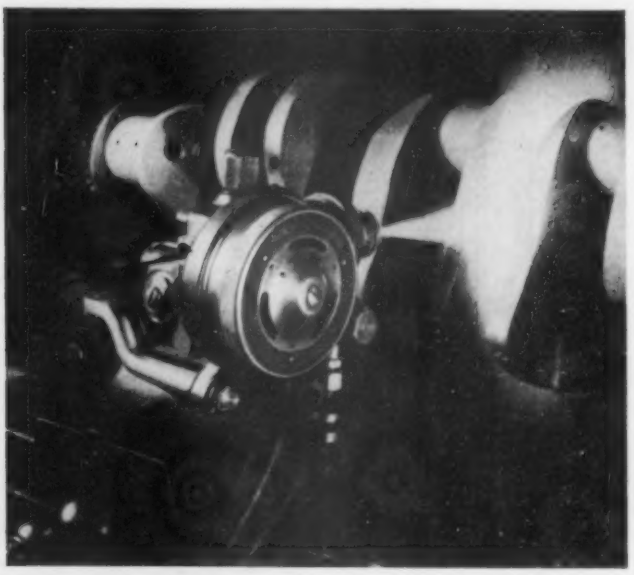


Fig. 5—New Metal Being Sprayed on the Prepared Shaft Journal

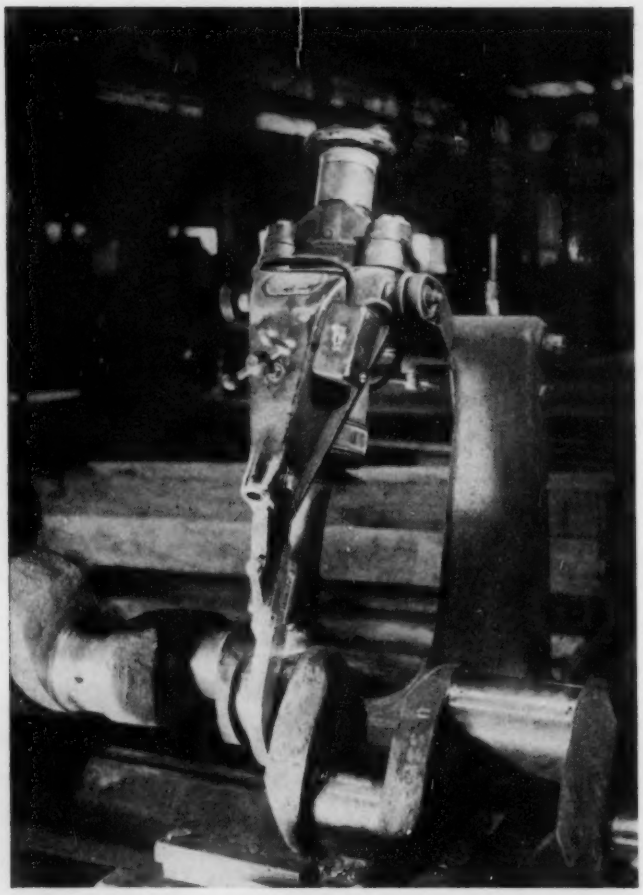


Fig. 6—Final Finishing Is Done by This Lathe-Mounted Tool

However, once constructed, the same flange and plate can be used on all subsequent crankshafts of the same size without repeating the elaborate setup. The keyway in the centering flange will always match the keyway in the crankshaft and thus will hold the centers in the flange in exact relationship to the centerline of the rod bearings. Moreover, the same setup used on 6-cylinder crankshafts can be used for 3-cylinder crankshafts of the same stroke.

Steps in Metallizing

The first step in the metallizing procedure itself is to machine the bearing 0.080 in. undersize. The edges of the undercut are dovetailed at 20° but *we never undercut the radii.* To do so will necessitate the "feather-edging" of the sprayed metal, a condition which will result in flaking and cracking at the edges in finishing. The undercut portion is grooved with a tool which has been ground to a width of 0.045 in. to 0.050 in., slightly rounded at the tip. These grooves are cut 0.025 in. apart and 0.020 in. deep, and the resulting condition is shown in Fig. 4.

The entire grooved surface is next treated with the Metco Rotary Shaft Preparing Tool, which had been modified by us in order to gain access to the rod bearing of a crankshaft. This treatment provides the many keys which firmly hold the sprayed metal in place.

A brief discussion of this method of preparation might be in order, as many engineers may object to cutting grooves into a crankshaft. However, a crankshaft is designed to present a large bearing area, and to accomplish this the diameter is often in excess of that necessary for strength alone. Therefore, the remaining diameter, when measured from the root of the grooves, is usually sufficient to support the working load.

If the shafts are not prepared in this manner, of which there are several variations, it becomes necessary to grit-blast them. A grit-blasted bond is not nearly so

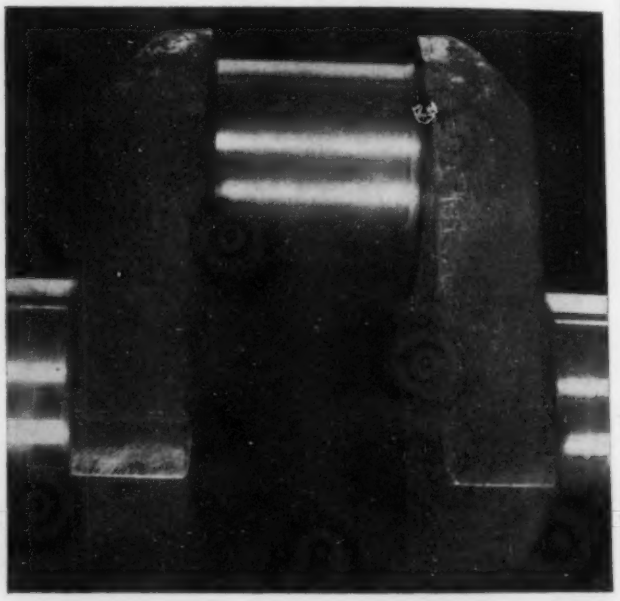


Fig. 7—Reclaimed Journal, Showing Excellent Surface Finish After Grinding

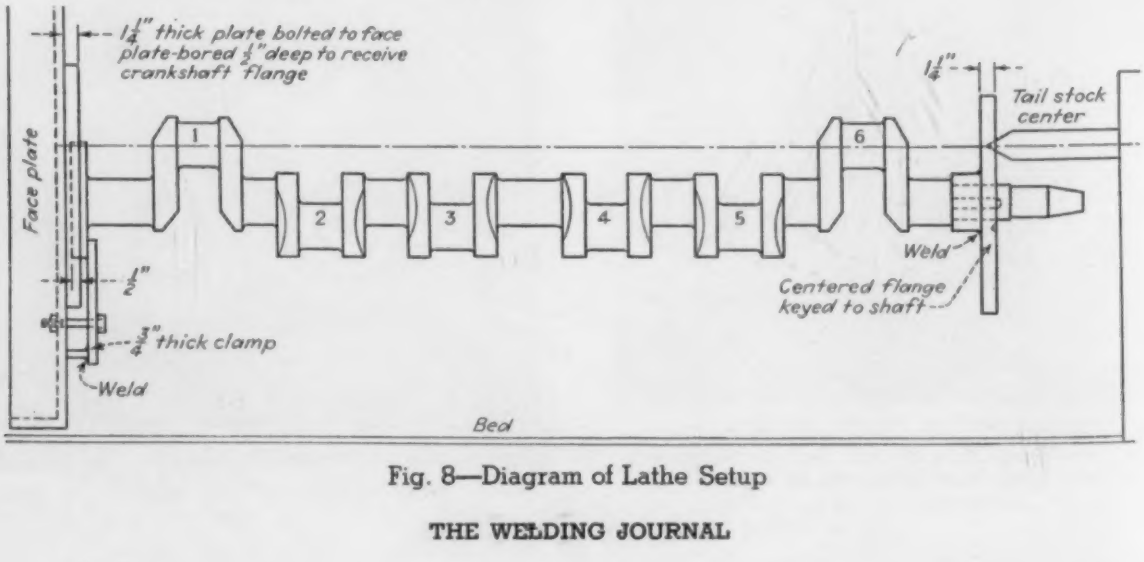


Fig. 8—Diagram of Lathe Setup

strong as the machined bond, and nearly all metallized crankshaft failures which have been brought to the attention of the writer have been those metallized onto a grit-blasted bond. All of our crankshafts have been grooved, and we have not had one failure due either to the loosening of the sprayed metal or to the breaking of the shaft.

Before the actual metallizing, all oil holes are plugged with carbon dowels, the tops of which project beyond the finishing dimension of the bearing. These dowels are removed only after the bearing is finished.

Spray metal is applied with the metallizing unit mounted on the tool post of the lathe, Fig. 5.

Medium carbon steel, with about 40 points (0.40) of carbon, is generally applied with one pass of the metallizing unit. The coating is built up to about 0.050 in. above the finishing size, after which the sprayed bearing is lathe-turned, using a carbide-tipped tool, to 0.006 in. larger than the finished size.

Finish Grinding

Final finishing is performed with a Sunnen portable lathe crankshaft grinder, as shown in Fig. 6. This machine, manufactured by the Sunnen Products Co., attaches to the back of the lathe carriage and grinds the rod bearing when either on the center line of the lathe or in the "throw-out" position.

A cup wheel, $2^1/_4$ in. diam. or smaller, is employed. The wheel is passed over the work by a hand-operated feed screw as the work is revolved, and is fed into the work by hand by means of a calibrated feed screw. The machine is also equipped with an adjustable eccentric mounting for eliminating taper.

The Sunnen Products Co. has cooperated with us by developing the proper type of wheel for the dry grinding of metallized coatings. This wheel can be obtained from the company by users of its equipment.

The Functions of a Welding Flux

By H. H. Griffith*

THE word "flux" is derived from the Latin word meaning "to flow." Oxyacetylene welding is fundamentally the process of melting two pieces of metal so that they will flow together and consolidate into one piece. The primary purpose of a flux is to facilitate this flowing together by removing obstacles to the union. These obstacles may be dirt or other foreign

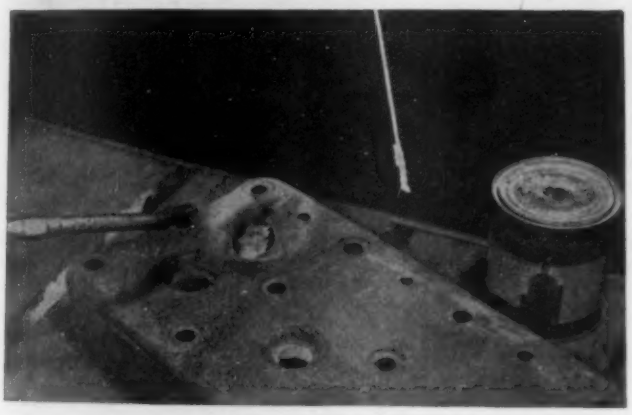


Fig. 1

The flux should adhere well but not too abundantly to the hot welding rod.

matter in the base metal but are principally the oxides formed as the metal melts.

Generally speaking, the oxides of all the ordinary commercial metals and alloys except steel have higher melting points than the metals themselves and are usually pasty (some are even infusible) when the metal is quite fluid and at the proper welding temperature. An efficient flux will combine with oxides to form a fusible slag having a melting point lower than the metal so that it will flow away from the immediate field of action. This

* The Linde Air Products Co., New York, N. Y.

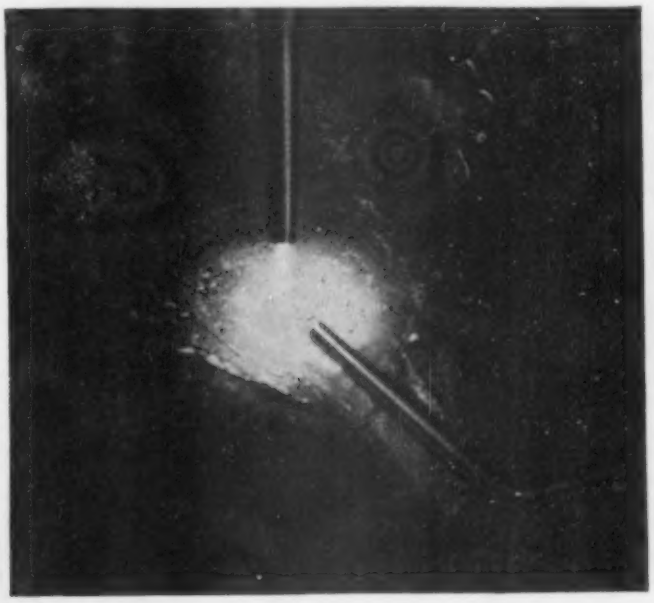


Fig. 2

A protective coating over the puddle prevents atmospheric oxidation.

slag, incidentally, forms a coating over the molten metal and thus serves as a protection against atmospheric oxidation. The chemical characteristics and melting points of the oxides of different metals vary greatly and therefore there can be no one flux that will be satisfactory for all metals.

Other Properties

A flux should have several other properties to be of maximum aid to the welding operator. It should be of such a nature that it will adhere to a hot welding rod in sufficient quantities so that it will be unnecessary to dip the rod in the flux can frequently, and it should cling to the rod firmly enough so that it will not be blown off by the welding flame before it reaches the area to be welded. On the other hand, if too much flux clings to the rod, wastage will result. The flux should fuse without violent boiling due to the evolution of water vapor or other gases and without the formation of dangerous or obnoxious fumes. Ammonia, ammonium chloride and other fumes, which are given off by some fluxes, irritate the eyes and

nostrils of the operator. This is not only annoying but sometimes actually obscures the operator's vision temporarily so that he cannot see what he is doing.

Melting Point

The melting point of a flux must be lower than that of either the metal or the oxides formed, so that it will be liquid. The ideal flux has exactly the right fluidity at the welding temperature and thus tends to blanket the molten metal from atmospheric oxidation. Such a flux remains close to the weld area instead of flowing over the base metal for some distance from the weld.

It can readily be appreciated that the behavior and chemical reactions of a flux are rather complicated and that good fluxes are not prepared haphazardly. A thorough knowledge of chemistry at high temperature and extensive practical welding experience are required. The use of make-shift homemade fluxes is usually inefficient and uneconomical and should never be tolerated—they often do more harm than good.

Welding of America's Cargo Ships

By A. F. Davis

WELDING of America's Liberty ships, which has already greatly speeded up their construction, may eventually bring about a cut in the necessary design factor-of-safety with a consequent reduction in cost and weight.

This word was received by our company from M. H. MacKusick, welding engineer for the California Shipbuilding Corp. (see Figs. 1 and 2).

There has been a great amount of argument over the dependability of welded construction for ships, and the old cry of locked-up stress in a welded ship has been presented as an argument against the extensive use of welds.

Few people stop to realize, he said, that any piece of cold-formed steel is stressed above the yield point during fabrication, else it could not have been shaped. Yet such yield point stresses have never seemed to cause concern. Furthermore, the strength or tightness of a riveted joint depends considerably on stresses established in the rivet when it cools from high temperature.

Samples of welds removed from sections of the welded ships may be bent through 180° without causing the welds to fail; yet a riveted joint subjected to a bend of only a few degrees would most certainly leak badly and would fail entirely through the rivet holes if subjected to a bend test such as that used in testing welds.

MacKusick pointed out that local locked-up stresses do exist in all fabricated structures. When these are subjected to changing load stresses in service, the local points of higher stress gradually adjust themselves.

"If the problem of corrosion can be completely solved, the design factor-of-safety for welded structures should be decreased with a consequent reduction of cost and weight.

"The structural design, however, would have to be carefully worked out to eliminate all sudden changes in continuity, such as so often exist adjacent to the integrally welded deckhouse midships, where working stresses are at a maximum. Proper erection and welding sequence would have to be used in construction. Ship designers can well afford to take a page out of the aircraft designer's book and make stress studies similar to the well-known 'wind tunnel' tests used in aircraft research."

Each Liberty ship constructed at the California Shipbuilding Corp.'s yard consumes 135,000 lb. of arc-welding rods, or 230,000 ft.

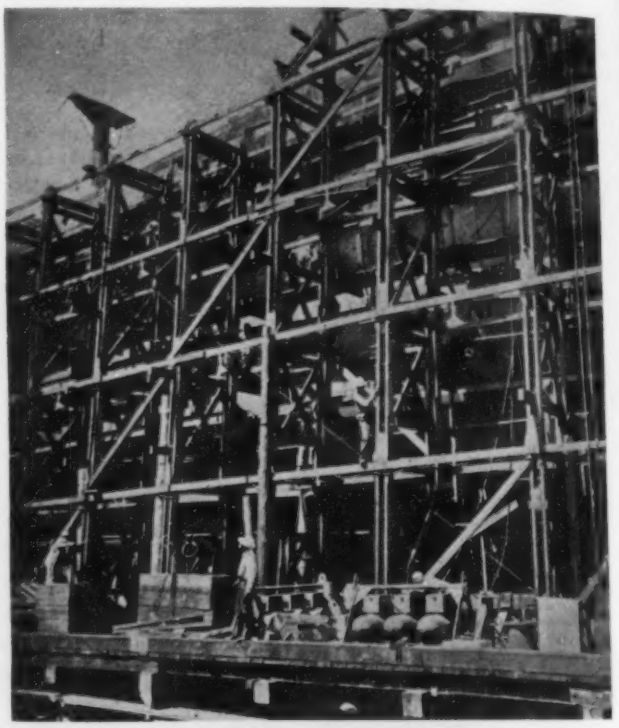


Fig. 1—Part of the Hull of Large Liberty Ship with Scaffolding Raised for Arc Welders at Work on the Structure

The yard, completing 15 ships every month, employs 6000 manual welders and 160 Union Melt operators. Every three shifts, a 65,000-lb carload of welding electrodes is used.

So far as practical, the welding is done on subassembled sections of the hull in a manner that provides a maximum of flat position welding. The large assembled sections are then erected and fitted on the shipways where the hull is finally welded into a complete structure.

The largest single assembly now being made in the Calship Yard is the "Forespeak" section which weighs 57 tons and is nearly 2½% of the total weight of the hull.

In the fabrication shop practically all the welding is done "in position" to provide for the use of large diameter electrodes and heavy welding current.

The manual welders in the shop average slightly more than 12 ft per man-hour. On the subassembly shop they average about 8 ft a man-hour, where more vertical position welding is done.

There is quite a large amount of vertical and overhead work done on the shipways. Much of this is in confined spaces, such as "double-bottom" tanks. There the welders are able to average only about 4 ft. per man-hour.

The advantage of subassembly and position welding is thus obvious. The ratio of 3 units of work positioned to 2 units of work subassembled, to 1 unit on the shipway is a very close average of the welding output per unit of time in the 3 divisions of the shipyard.

* Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

A.W.S. Emergency

A.W.S. Emergency Standard

RECOMMENDED PRACTICE FOR THE SPOT WELDING AND SEAM WELDING OF LOW CARBON STEEL

Approved for publication by R. W. Clark, Chairman, Committee on Outline of Work, April 29, 1943

THE data submitted on the following charts have been compiled by canvassing approximately 60 fabricators of mild steel structures and resistance welding equipment manufacturers. It is the best information available at this time for low carbon steel spot and seam welding; it is recommended as standard practice during the war emergency. The work was initiated by the Resistance Welding Research Committee of the Welding Research Council and has been approved by the Resistance Welding Standards Committee of the AMERICAN WELDING SOCIETY.

The data were compiled for mild steel (S.A.E.-1010) for thicknesses up to 0.125 in. The Standardization Subcommittee will publish at a later date welding data on high carbon steels (such as X4130) and heavier gages of mild steel.

The information in the charts has been arranged in the order in which a welding operator or supervisor would set up a welding machine. For instance, after the metal gage is determined the welding electrode or roll is selected, the pressure is adjusted, the weld time is then set and a pull test made. This is the order in which the data appear from left to right on the welding charts.

LOW CARBON SPOT WELDING DATA

Two forms of electrodes were suggested by several manufacturers. One is the type shown at the top of the column entitled "Electrode Diameter and Shape." The other was a straight electrode with dome type tip with a $2^1/_2$-in. radius. We have shown the former because it was more currently used but both types are acceptable provided the diameter of the contact surface (*d*) is held to the values indicated. The large diameter of the electrode (*D*) is a minimum diameter; in other words, a diameter less than that indicated will cause excessive "mushrooming" of the tips.

Net Electrode Force refers to the exact force between contact surfaces.

Welding Current has been given approximately to help specify and calculate the capacity of welding machines. It should not be used as an exact value to obtain a given weld strength.

Minimum Weld Strength, as explained in footnote 7, is that strength which should be obtained for highly stressed structures. A simple pull test in a reliable testing machine with the samples unconfined is the accepted method of checking this value. For structures with a high inherent factor of safety, the minimum strength indicated could be reduced approximately 30%. Recommended test metal sizes are given under Army Air Corps specification No. 20011-C.

Diameter of fused zone data should be helpful if cross-sectional etch tests are made to check penetration of the weld in the outside thicknesses.

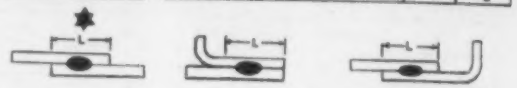
Minimum lap indicates the required overlap as shown in the sketches at the bottom of the chart. It is extremely important not to go below the values shown, otherwise the weld will be too small and difficult to maintain under shop conditions.

Spacing is indicated for twice the thickness of the thinnest outside piece (2"T") and three times the thickness of the thinnest outside piece (3"T"). As explained in footnote 4 the minimum spacing is that distance for which

LOW CARBON STEEL SPOTWELDING DATA

THICKNESS OF THINNEST OUTSIDE PIECE "T"		MINIMUM ELECTRODE DIA. & SHAPE (d = MIN.)		NET ELECTRODE FORCE	WELD TIME	APPROX. CURRENT	MINIMUM WELD STRENGTH	APPROXIMATE DIAMETER OF FUSED ZONE	MINIMUM OVERLAP * "L"	MINIMUM WELD SPACING ℄ TO ℄	
INCHES	GAGE	d INCHES	D	POUNDS	CYCLES (60 PER SECOND)	AMPERES	POUNDS	INCHES	INCHES	2 "T"	3 "T"
0.010	32	1/8	3/8	200	4	4000	200	0.10	3/8	1/4	1/4
0.020	26	5/16	3/8	300	6	5500	450	0.13	7/16	3/8	3/8
0.030	22	3/16	3/8	400	8	7000	800	0.16	7/16	1/2	3/4
0.040	20	1/4	1/2	500	10	8000	1200	0.19	1/2	3/4	1
0.050	18	1/4	1/2	650	12	9000	1750	0.22	9/16	7/8	1 1/4
0.060	16	1/4	1/2	800	14	9600	2300	0.25	9/16	1	1 3/8
0.080	14	5/16	5/8	1100	17	10800	3450	0.29	11/16	1 1/4	1 1/2
0.094	13	5/16	5/8	1300	20	11500	4250	0.31	3/4	1 1/2	1 3/4
0.109	12	3/8	3/4	1600	23	12000	5200	0.32	3/4	1 5/8	2
0.125	11	3/8	3/4	1800	26	12600	6000	0.33	7/8	1 3/4	2 1/4

NOTES:
1. TYPE OF STEEL- SAE 1010.
2. MATERIAL FREE FROM GREASE, SCALE, & DIRT.
3. DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 3 "T"
4. MINIMUM SPACING IS THAT SPACING FOR WHICH NO SPECIAL PRECAUTIONS NEED BE TAKEN TO COMPENSATE FOR SHUNTED CURRENT EFFECT OF ADJACENT WELDS.
5. THICKNESS OF THINNEST OUTSIDE PIECES DETERMINE WELDING CONDITIONS.
6. ELECTRODE MATERIAL
   MINIMUM CONDUCTIVITY- 75% OF COPPER.
   MINIMUM HARDNESS- 75 B ROCKWELL.
7. STRENGTHS SHOWN FOR HIGHLY STRESSED STRUCTURES



no special precautions need be taken to compensate for the shunted current effect of adjacent welds. This shunted current effect is greater for heavier pile-ups, hence the increased spacing for 3"T."

LOW CARBON STEEL SEAM-WELDING DATA

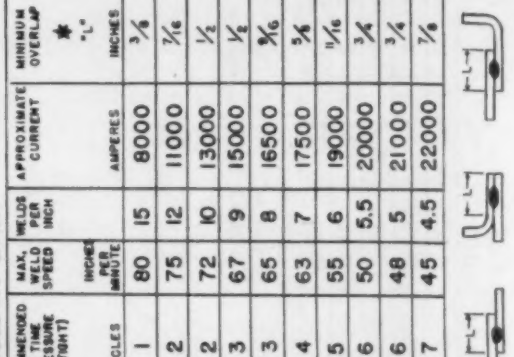
The data on this chart are similar to the spot-welding chart. It is intended for pressure tight seam welding, therefore, indicates welding roll width instead of electrode diameter.

"On times" and "off times" indicates the time during which the current is flowing and interrupted. If a slower welding speed is necessary the "off time" should be increased, rather than increase the number of welds per inch. A greater number of welds per inch than those values indicated results in excessive heat input; this might tax the equipment unnecessarily and cause undue distortion of the work.

LOW CARBON STEEL SEAM WELDING DATA

THICKNESS OF THINNEST OUTSIDE PIECE "T" INCHES	GAGE	ROLL WIDTH & SHAPE W MIN. d D	NET ROLL FORCE POUNDS	ON TIME CYCLES (60 PER SECOND)	RECOMMENDED OFF TIME (PRESSURE TIGHT) CYCLES	MAX. WELD SPEED INCHES PER MINUTE	WELDS PER INCH	APPROXIMATE CURRENT AMPERES	MINIMUM OVERLAP * "L" INCHES
0.010	32	3/16 3/4	400	2	1	80	15	8000	3/8
0.020	26	3/16 3/4	550	2	2	75	12	11000	7/16
0.030	22	1/4 1/2	700	3	2	72	10	13000	1/2
0.040	20	1/4 1/2	900	3	3	67	9	15000	1/2
0.050	18	5/16 1/2	1050	4	3	65	8	16500	9/16
0.060	16	3/8 1/2	1200	4	4	63	7	17500	5/8
0.080	14	3/8 3/4	1500	6	5	55	6	19000	11/16
0.094	13	7/16 3/4	1700	7	6	50	5.5	20000	3/4
0.109	12	1/2 3/4	1950	9	6	48	5	21000	3/4
0.125	11	1/2 3/4	2200	11	7	45	4.5	22000	7/8

NOTES:
1 TYPE OF STEEL SAE 1010.
2 MATERIAL FREE FROM GREASE, SCALE, & DIRT.
3 DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 3"T"
4 WELD STRENGTH WITH WELDS PER INCH AS SHOWN EQUALS APPROXIMATELY 85% STRENGTH OF PARENT METAL.
5 THICKNESS OF THINNEST OUTSIDE PIECES DETERMINE WELDING CONDITIONS
6 ROLL MATERIAL:
MINIMUM CONDUCTIVITY-75% OF COPPER.
MINIMUM HARDNESS-75B ROCKWELL.



Welding Methods for National Emergency Steels

By A. N. Kugler*

SINCE the introduction of the National Emergency or NE Steels some months ago as a simplification measure, considerable discussion has been forthcoming on the problems, if any, encountered in working these steels. Little has been said, however, on the subject of welding procedures for these steels, perhaps because it was generally understood that the welding of NE steels presents no new or unusual problems. Nevertheless questions occasionally arise, indicating that some hesitation exists, at least among those unfamiliar with the welding of steels having analyses similar to those in the NE group.

Since these steels differ from standard alloy steels chiefly in the amounts of alloying elements present, and since the effect upon weldability of each constituent is fairly definitely known, one or another of the established welding procedures will be appropriate for welding these alternate steels.

The basis for determination is, of course, carbon content and hardenability as governed by the amounts of other hardening elements present. The welding procedure will be further influenced by the section of the fabricated piece—whether it is light gage material or of heavy thickness. Likewise, selection of filler metal is affected by the physical characteristics required of the weld, or the service to which it will be put. Thus, a low carbon alloy steel rod is called for when ductility is most essential, and a higher carbon filler metal is used when hardness and wear resistance are required, or where the part will subsequently be flame hardened.

While the foregoing statements are quite general and are in no way out of the ordinary, they serve to accentuate the fact that these alternate steels are readily weldable by ordinary procedures. In those cases where the substitute steel is similar in composition to the original alloy which it replaces, it is usually possible to use the same procedure and the same welding rod or electrode as formerly.

Bearing in mind the differences in procedure which are dictated by the size of the weld and the ultimate service conditions, certain general recommendations may be made by classifying the emergency steels into groups. At the top of the list, those with low carbon content and those in the nickel-chromium group having low carbon, may be welded with standard low carbon alloy steel rod or electrode. The medium carbon steels in both groups may be welded with the same filler metal, but better physical properties are obtained by using rods of higher carbon and manganese content. The higher carbon steels in both the manganese-moly group and the nickel-chromium group may be welded with a standard 0.15 C nickel-chromium alloy rod or a standard electrode.

Since virtually all of these alloys having more than 0.30 carbon are air-hardened steels, care must be taken to minimize this effect When welding with the oxy-acetylene flame, use the backhand technique to keep the puddle constantly protected by the flame and the flame streamer. A slightly excess acetylene flame should also be used on the higher carbon steels, and care should be taken to eliminate turbulence as much as possible.

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Proposed Tentative Tests

at an elevated or a subnormal temperature. The following temperatures are standard:

Normal temperature.....60 to 70° F.
300° F.

Proposed Tentative Tests for METAL ARC WELDABILITY OF STEELS

FOREWORD

THE tests given below have been prepared by the Subcommittee on Weld Bead Hardness Test and Subcommittee on Tee Bend Test, respectively, of the Committee on Weldability of Steels. With the dissolution of this Committee, these reports of the Subcommittees have been transmitted to the Committee on Standard Tests for Welds for further study and publication. They are being presented for the purpose of securing comments and criticisms. To be effective comments should be received not later than July 10, 1943. Communications should be addressed to the Committee on Standards Tests for Welds, American Welding Society, 33 West 39th Street, New York City.

The two tests prescribed hereinafter are intended to determine the weldability of a steel as defined by the effect of the heat cycle which the steel undergoes during the welding process as evidenced by the change of hardness and loss of ductility of the material.

A. WELD BEAD HARDNESS TEST

This test is intended to indicate the hardening or cracking effect on a steel specimen under standardized conditions when a single bead of weld is deposited thereon.

1. Preparation of Test Plate

(*a*) *Dimensions of Test Plate*

The test plate for the weld bead hardness test shall comply with the requirements of Fig. 1. The surface of the plate on which the weld is deposited shall be ground or shot blasted to remove scale or surface oxide prior to depositing the bead.

(*b*) *Condition of Test Plate*

The test plate shall be in the normalized condition.

(*c*) *Temperature of Plate Prior to Welding*

The test may be conducted with the test plate at normal temperature or at an elevated or a subnormal temperature. The following temperatures are standard:

Normal temperature	60 to 70° F.
Elevated temperature	300° F.
Subnormal temperature	−20° F.

(*d*) *Welding Procedure*

The weld bead shall be deposited by the following welding procedure:

Electrode Classification No.	E6010*
Electrode Size	3/16 in.
Type of Current	d. c., reverse polarity
Arc Voltage	24 to 26 volts
Amperage	180 amp.
Speed of Travel	5 in. per min.

Welding Details—Weld beads made on test plates at elevated or sub-normal temperatures shall be started within a period of one minute after the test plate is removed from the heating or cooling medium. The weld shall be deposited without oscillation of the electrode. After welding the test plate shall be allowed to cool in still air at room temperature (60 to 70° F).

NOTE: The welding shall preferably be done with an automatic welding

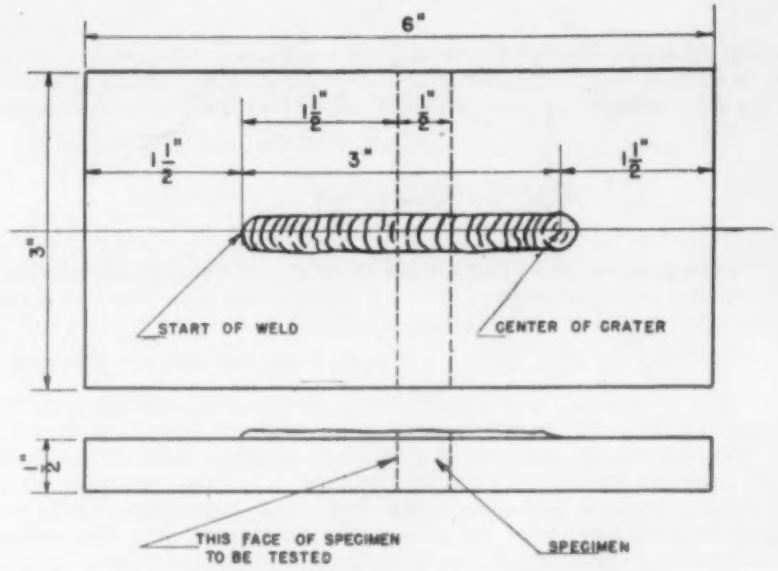


Fig. 1—Test Plate for Weld Bead Hardness Test

* This classification number refers to the A.W.S.-A.S.T.M. Tentative Specifications for Iron and Steel Arc Welding Electrodes (A.S.T.M. Serial Designation A 233 – 42 T).

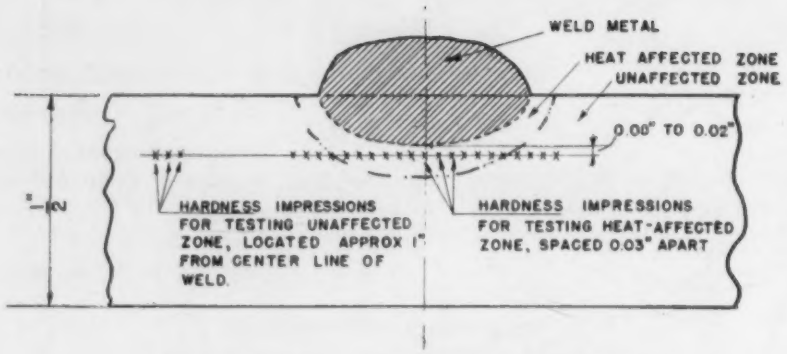

WELD METAL
HEAT AFFECTED ZONE
UNAFFECTED ZONE
0.00" TO 0.02"
HARDNESS IMPRESSIONS FOR TESTING UNAFFECTED ZONE, LOCATED APPROX 1" FROM CENTER LINE OF WELD.
HARDNESS IMPRESSIONS FOR TESTING HEAT-AFFECTED ZONE, SPACED 0.03" APART

Fig. 2—Specimen for Weld Bead Hardness Test

machine. If an automatic welding machine is not available it is recommended that the weld be made in such a way that the operator controls only the feed of the electrode, while a mechanical device is used to move the test plate forward at the prescribed rate.

2. Preparation of Specimen

(*a*) *Removal from Test Plate*

The specimen shall be removed from the test plate as shown in Fig. 1. The cross-sectional faces of the specimen shall be ground to produce parallel surfaces.

(*b*) *Polishing*

The face to be tested shall be polished to produce a finish sufficiently smooth so that accurate Vickers hardness readings can be obtained with a 10-kg. load.

NOTE: A recommended procedure for obtaining this finish is as follows: Polish with emery paper down to grade 000; finish polishing on a lap wheel or on metallographic polishing equipment with a fine grade of alumina.

(*c*) *Etching*

The face of the specimen to be tested shall be etched in an area at and adjacent to the weld with any reagent which makes the boundary between the weld metal and the base metal visible, without overetching to the extent that difficulty will be encountered in securing accurate hardness readings on the etched surface.

NOTE: The etching should be limited to the minimum strength of reagent and time that will show the junction of the weld metal and the heat-affected zone, as overetching causes difficulty in obtaining accurate hardness readings. Four per cent picric acid or one per cent nital are recommended for carbon and low-alloy steels.

3. Testing of Specimen

(*a*) *Hardness of Heat-Affected Zone*

Vickers hardness readings shall be made in the heat-affected zone as shown in Fig. 2, using a 10-kg. load for 30 sec. The first reading shall be taken at a point on the center line of the weld and between 0.00 in. and 0.02 in. from the boundary between the weld metal and the base metal. Subsequent readings shall be taken at 0.03-in. intervals both to the right and to the left, on a line parallel to the surface of the base metal, until there is a substantial decrease in the hardness noted.

(*b*) *Hardness of Unaffected Base Metal*

Three Vickers hardness readings shall be made in the unaffected zone in a location on a line with the readings taken in the heat-affected zone and at a distance of approximately 1 in. from the center line of the weld bead.

4. Results

(*a*) *Visual Examination*

Both cross-sectional faces of the specimen shall be examined for the appearance of cracks, with a 5- to 25-power magnifying glass, before and after etching. Any cracks discovered shall be reported, together with the location thereof.

(*b*) *Hardness of Heat-Affected Zone*

The maximum hardness readings obtained in the heat-affected zones to the right and to the left of the bead shall be reported.

(*c*) *Hardness of Unaffected Base Metal*

The three hardness values obtained shall be averaged. The resultant average value shall be reported.

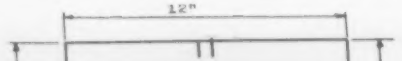
5. Recording of Results

The results of the test shall be set forth in a suitable permanent record.

NOTE: The following form for reporting the results is recommended:

Record of Weld Bead Hardness Test

1. Type of Steel:.....
2. Chemical Analysis: C Na P S Si Ni Cr Cu Mo V .....
3. Deoxidation Practice: Killed ..... Semi-Killed ..... Rimmed .....
4. Grain Size (McQuaid-Ehn):.....
5. Normalizing Treatment:.....
6. Welding Data:
   (*a*) Type and Size Electrode.....



affected zone, as overetching causes difficulty in obtaining accurate hardness readings. Four per cent picric acid or one per cent nital are recommended for carbon and low-alloy steels.

6. Welding Data:
   (*a*) Type and Size Electrode.....
   (*b*) Type of Current.....Polarity.....
   (*c*) Amperage.....
   (*d*) Voltage.....
   (*e*) Rate of Travel.....
   (*f*) Plate Temperature.....
7. Hardness of Heat-Affected Zone (Max.): Right.....Left.....
8. Hardness of Unaffected Base Metal (Avg.):.....
9. Visual Examination for Cracks:.....

Signature.....

Date.....

B. TEE-BEND TEST

This test is intended to indicate the inherent weldability of a steel by a test made under standardized conditions. Results are indicated both by the change in hardness as manifested by a comparison between hardness readings taken in both the heat-affected and non-affected zones of the joint, and by the absence of cracking in the welded specimen as manifested by a prescribed bend test.

1. Preparation of Specimen Assembly

(a) Dimensions of Specimen Assembly

The specimen assembly for the tee bend test shall conform to the dimensions given in Fig. 1.

(b) Condition of Specimen Assembly

The plates of the specimen assembly shall be of the material under investigation, and shall be in the as-rolled condition. Loose scale and other foreign material shall be removed by wire brushing from the surfaces of the assemblies prior to welding.

NOTE: For information purposes other plates may be normalized, annealed or quenched and tempered prior to welding.

(c) Temperature of Assembly Prior to Welding

The specimen assembly may be at normal temperature or at an elevated or a subnormal temperature when welding is started. The following temperatures shall be considered standard:

Normal temperature	60 to 70° F.
Elevated temperature	300° F.
Subnormal temperature	− 20° F.

NOTE: These tests are usually made with the specimen assembly welded

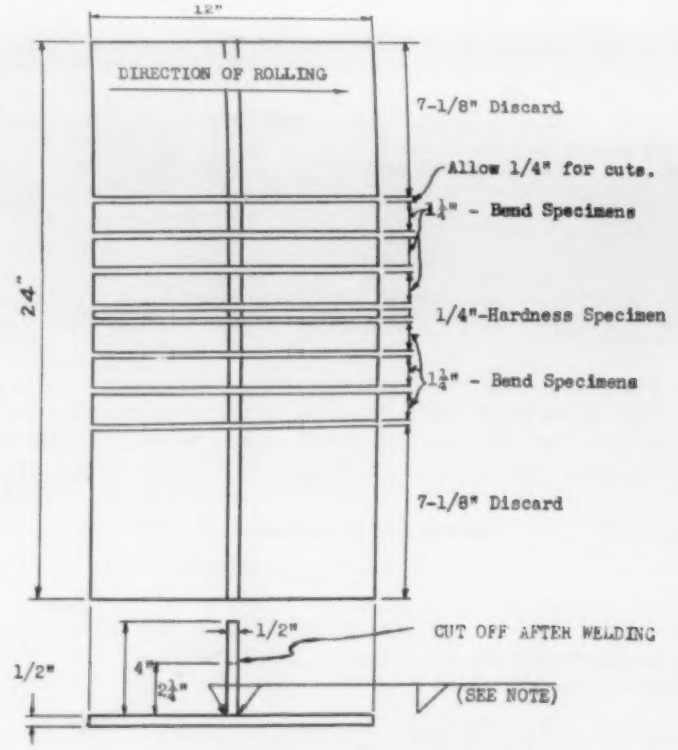


Fig. 1—Test Plate for Tee Bend Test

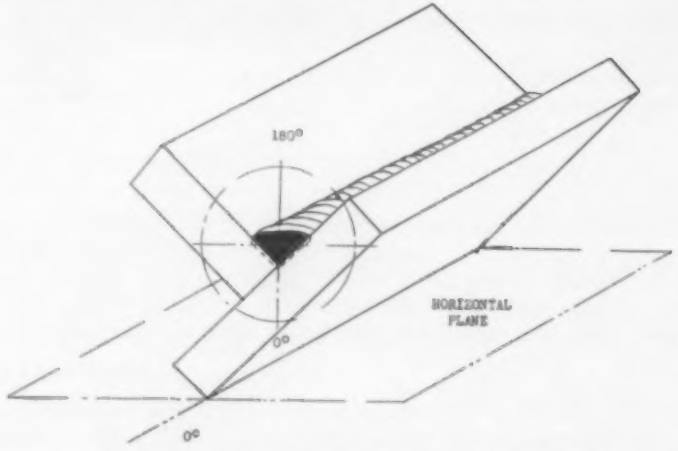


Fig. 2—Absolute Flat Position of Fillet Weld

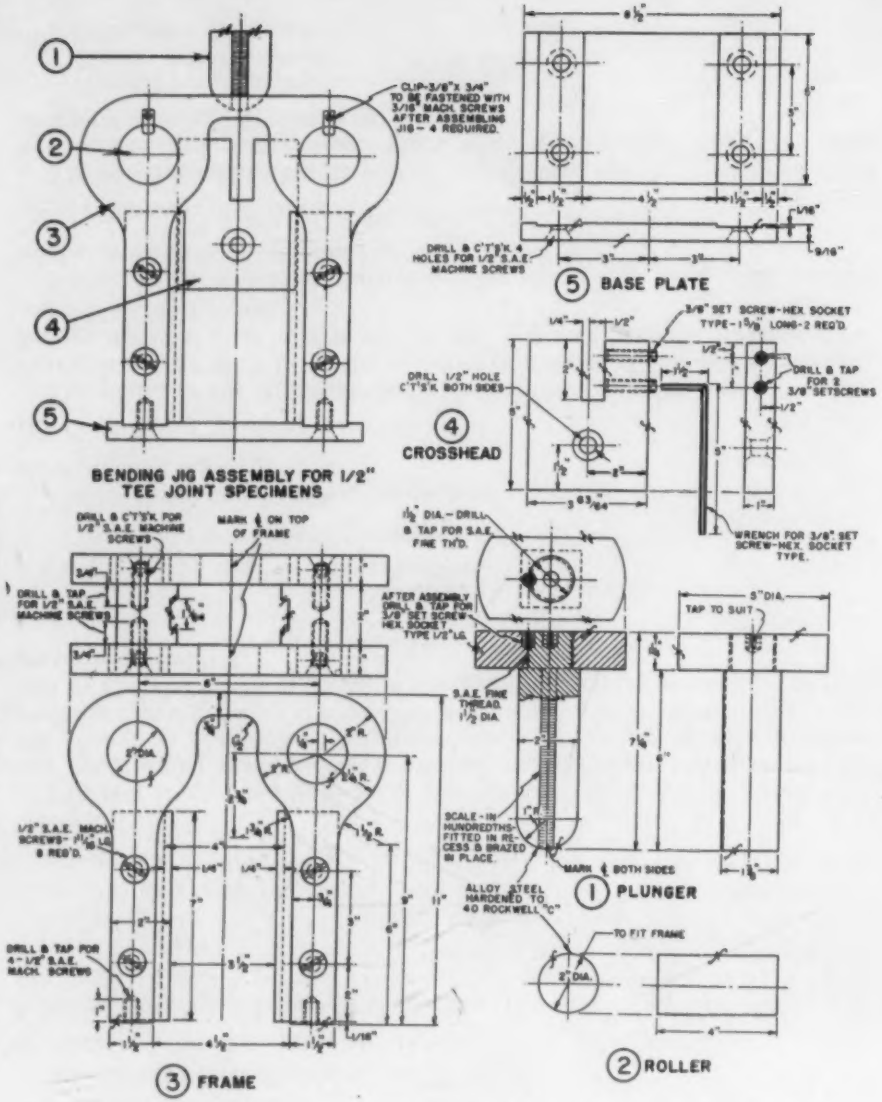


Fig. 3—Bending Jig Assembly and Details for 1/2-In. Tee Joint Specimens

at normal temperature only. If welds are deposited on plates cooled to −20° F., it is recommended that the preparation of the assembly be accomplished in a room in which a constant atmospheric temperature of −20° F. is maintained. If this is not practical, the assembly may be cooled in a refrigerated liquid medium to this temperature prior to welding.

After welding the first side, the assembly should be cooled below 212° F. in air before again immersing in the cooling medium.

(d) Welding Procedure

The welds shall be manually deposited in the absolute flat position as illustrated in Fig. 2 to obtain a single layer continuous fillet. The assembly shall return to the original temperature before deposition of the fillet on the opposite side of the vertical member.

The following standard conditions shall be used for the deposition of the fillets:

Electrode Classification No.	E6010*
Electrode Size	5/32 in.
Arc Voltage	26 to 28 volts
Amperage	130 to 135 amp.
Fillet Size	See note below

NOTE: The fillets shall be deposited as follows: Increments $2^{11}/_{16}$ in. long of complete fillet shall be deposited with $9^{1}/_{4}$ to $9^{3}/_{4}$ in. of electrode. As many successive increments of this length shall be deposited as is necessary to weld the fillet along the entire length of test plate. A period of exactly 45 sec. should elapse between the deposition of increments to permit changing of electrode.

The welding on both sides of the joint shall progress from the same end of the assembly. The result shall be welds free from undercutting with minimum convexity and approaching as nearly as possible a 45° right triangle.

2. Preparation of Specimens

(a) Removal from Assembly

The specimens (six for bend testing and one for hardness tests and microscopic examination) shall be removed from the assembly as shown in Fig. 1 by sawing or milling. The removal of specimens by oxygen cutting shall not be permitted.

* This classification number refers to the A.W.S.-A.S.T.M. Tentative Specifications for Iron and Steel Arc Welding Electrodes (A.S.T.M. Serial Designation A 233-42 T).

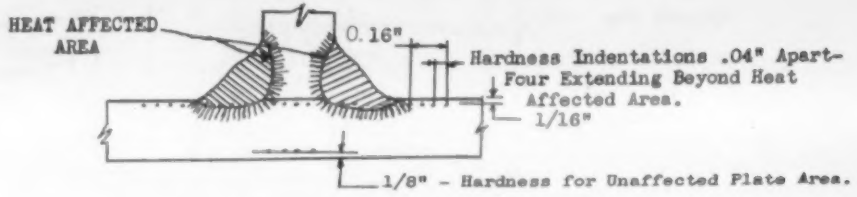

HEAT AFFECTED AREA
0.16"
Hardness Indentations .04" Apart-Four Extending Beyond Heat Affected Area.
1/16"
1/8" - Hardness for Unaffected Plate Area.

Fig. 4—Specimen for Tee Bend Test

(b) Tee Bend Specimens

The faces of the welds shall not be filed, ground or machined in any manner. The tension edges of the plate metals shall be broken slightly

The first indentation shall be made in the plate metal 0.16 in. from the junction of the weld and

cooled in a refrigerated liquid medium to this temperature prior to welding.

(b) Tee Bend Specimens

The faces of the welds shall not be filed, ground or machined in any manner. The tension edges of the plate metals shall be broken slightly with a file.

(c) Hardness Specimen

The face of the hardness specimen shall be polished to produce a finish sufficiently smooth so that the Vickers indentations may be accurately read.

NOTE: When the hardness specimen is used also for microscopic examination, it is suggested that the specimen be polished in the usual manner, etched and examined, after which the Vickers indentations may be made.

3. Testing of Bend Specimens

(a) Specimens

Ordinarily three bend specimens from one assembly are tested at a given temperature. The extra specimens may be used for replacing rejected specimens or for testing at elevated or subnormal temperatures. If all specimens from one assembly are rejected a new assembly shall be fabricated under the same conditions as the original assembly.

(b) Bending Apparatus

The essential features of the bending apparatus shall be as shown in Fig. 3.

NOTE: Testing is normally done at room temperature but if information concerning low-temperature bending properties is desired, a testing temperature of −20° F. is recommended. When testing at low temperatures the jig and specimen must be placed in a tank and completely covered with a cooling liquid during the entire period of test.

(c) Procedure

The vertical member of the specimen shall be secured in the slot of the crosshead of the bending apparatus. Pressure shall be applied through the plunger attached to the movable head of a testing machine which may be of a vertical screw or hydraulic type, and with a beam, dial or other suitable means for indicating the load. The downward feed of the plunger shall be continued until the angle of bending is 120° or until the specimen has entirely fractured.

4. Testing of Hardness Specimen

(a) Hardness of Heat-Affected Zone

One row of Vickers hardness indentations, using a 30-kg. load for 10 sec., shall be made $^1/_{16}$ in. below the surface of the plate as shown in Fig. 4. The first indentation shall be made in the plate metal 0.16 in. from the junction of the weld and plate metals of one weld. Subsequent indentations shall be made at 0.04-in. intervals across both welds to a point 0.16 in. beyond the junction of plate and weld metals of the second weld.

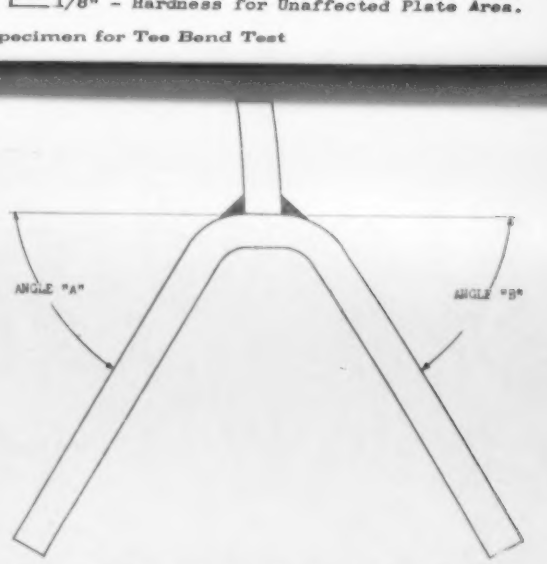


Fig. 4—Specimen for Tee Bend Test

(b) Hardness of Unaffected Plate Metal

Three Vickers hardness indentations shall be made in the plate metal $^1/_8$ in. from the bottom approximately between the two welds as shown in Fig. 4.

Fig. 5—Method of Measuring Angle of Tee Bend Specimens

5. Results of Tee Bend Tests

(a) *The Maximum Load*, indicated by a drop of the beam or by the highest load indicated on the dial, shall be recorded.

(b) *The Bending Angle* at the maximum load shall be measured and recorded.

NOTE: This angle is the supplement of the included angle through which the base plate of the assembly has been bent or the sum of angle *A* and angle *B*, Fig. 5.

(c) *The Load and Angle* at first evidence of fracture shall be recorded.

(d) *Fractures* shall be classified as follows:

Type 0.—The specimen bends to 120° without fracture or tear of any kind.

Type 1.—A crack which starts in the bond zone at the toe of the fillet and follows the fusion zone under the weld, but does not turn into the plate metal.

Type 2.—A slowly progressing crack which starts at the toe of the fillet and extends either directly into the plate metal or follows the fusion zone for a short distance and then turns into the plate metal, but does not continue entirely across the plate.

Type 3.—A sudden or sharp crack which generally starts at the toe of the fillet and extends into and entirely across the plate metal.

6. Results of Hardness Tests

(a) Hardness and Heat-Affected Zone

The maximum hardness obtained in the heat-affected zones shall be recorded.

(b) *Hardness of Unaffected Plate Metal*

The average of the three hardness values shall be recorded.

7. Recording of Results

The results of the test shall be recorded on a suitable permanent form.

NOTE: The following form for reporting the results is recommended.

Record of Tee-Bend Test

1. Type of Steel:.....
2. Chemical Composition:..... C Mn P S Si Cu Ni Cr Mo V .....
3. Deoxidation Practice: Killed..... Semi-Killed..... Rimmed.....
4. Grain Size (McQuaid-Ehn):.....
5. Heat Treatment:.....
6. Electrode Brand:.....
7. Original Plate Temperature:.....
8. Testing Temperature:.....

Specimen	1	2	3	....
9. Maximum Load:.....				
10. Angle of Bending at Maximum Load:.....				
11. Load at Initial Fracture:.....				
12. Angle of Bending at Initial Fracture:.....				
13. Type of Fracture:.....				
14. Hardness of Heat-Affected Zone (Max.):.....				
15. Hardness of Unaffected Plate Metal (Avg.):.....				
16. Remarks:.....				

Signature.....

Date.....

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Kinks for the Cutting Operator

By R. S. Babcock*

IT IS of utmost importance today, when industry is bending every effort to speed up wartime production, that every tool, machine and piece of equipment in the shop should operate at maximum efficiency. This is particularly true of oxyacetylene welding and cutting apparatus. Here, sometimes, a little extra care in the method of adjusting the blowpipe or in its manipulation will produce gratifying results.

Nozzle Settings

The efficiency of a cutting blowpipe, even a brand new one, will be materially increased, for example, if the cutting nozzle is positioned in the blowpipe head so that the preheating orifices bear the proper relation to the direction of the line of cut. When a square cut is to be made, that is, one in which the cutting-oxygen jet is perpendicu-

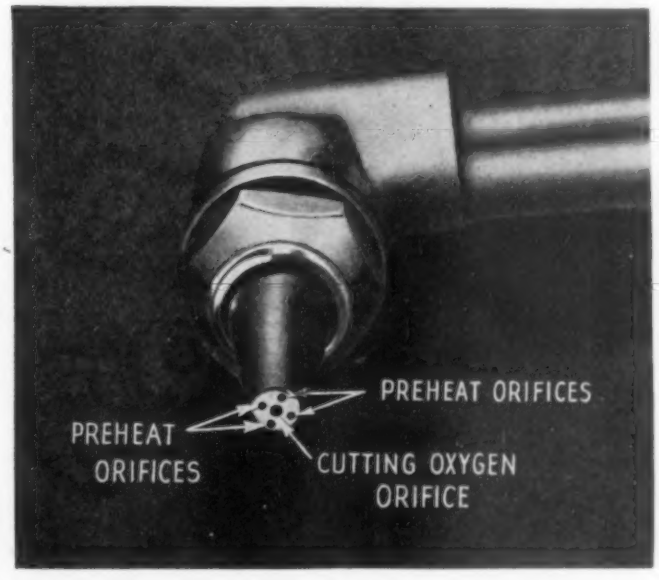

Fig. 1—Close-up of the End of a Cutting Nozzle Showing the Relative Position of the Orifices

* The Linde Air Products Co., Newark, N. J.

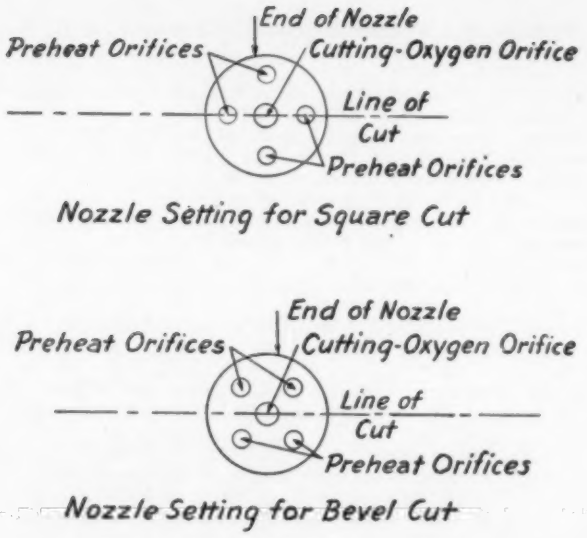

Fig. 2

This sketch shows the difference in nozzle settings for making square and bevel cuts.

lar to the surface of the steel, before tightening the nozzle-retaining nut, the nozzle should be set so that two preheating flames will fall directly on the line of cut—one immediately preceding the cutting oxygen, and the other following it, as shown in the upper sketch in Fig. 2. This will produce a much cleaner, neater cut with less oxide adhering to the cut edges.

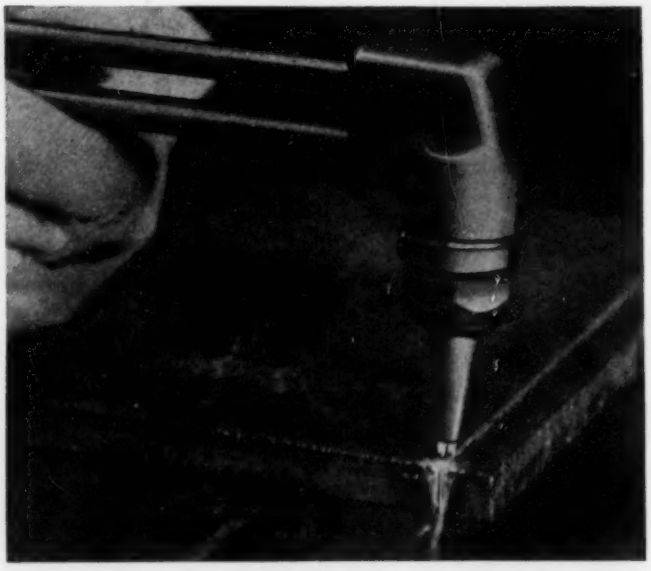

Fig. 3

In a square cut, the ends of the inner cones of the preheating flames should just touch the surface of the work.

Bevel Cuts

When making a bevel cut, a directly opposite setting of the nozzle should be made. The preheating orifices should be on either side of but not directly on the line of cut, as shown in the lower sketch in Fig. 2. With this setting of the nozzle, much better distribution of the preheating heat will be attained, since in a bevel cut the preheating flames are inclined at an angle to the surface of the steel.

Preheating Flames

Holding the nozzle at the proper distance from the surface of the work is another factor in efficient cutting. In a square cut, the ends of the inner cones of the preheating flames should just touch the surface, but in a

Fig. 4

In a bevel cut, actual cutting is through metal considerably thicker than the thickness of the plate.

bevel cut better heat distribution will be obtained if they are held $^{3}/_{8}$ of an inch or more above the surface, depending upon the thickness of the metal to be cut.

It should also be borne in mind in making a bevel cut that the thickness of the metal on the line of cut is considerably greater than the thickness of the plate—for example, in cutting a 45° bevel in 2-in. plate the actual cutting is through metal almost $2^{7}/_{8}$ in. thick. This difference in thickness is clearly shown in Fig. 4. The greater thickness often requires the use of the next larger size nozzle with correspondingly higher pressures. Consult the blowpipe manufacturer's cutting chart for the proper size nozzle to use for various thicknesses.

By doing a little experimenting on scrap material, the cutting operator can easily prove to himself that observation of these points will increase the quality of his work and at the same time will also save oxygen.

Sections—CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

ATLANTA — 1st Fri.
CHAIRMAN—MICHAEL C. STELLMAN, 1164 N. Highland Ave., N. E. Atlanta, Ga.
SECRETARY—J. V. TURNER, Air Reduction Sales Co., 336 Spring St., N. W., Atlanta, Ga.

BIRMINGHAM — 3rd Fri.
CHAIRMAN—C. C. PINCKNEY, Birmingham Boiler & Eng. Co., 41st St. & 8th Ave., North, Birmingham, Ala.
SECRETARY-TREASURER—W. L. POOLE, Air Reduction Sales Co., 2825 N. 29th Ave., Birmingham, Ala.

BOSTON — 2nd Mon.
CHAIRMAN—F. W. DAVIS, E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.
SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

CANAL ZONE — 1st Tues.
CHAIRMAN—CLIFFORD B. JONES, Box 533, Diablo Heights, Canal Zone
SECRETARY—R. E. HOLLICK, Box 924, Diablo Heights, Canal Zone

CHATTANOOGA, TENN. — 1st Wed.
CHAIRMAN—ROY E. LORENTZ, Combustion Engineering Co., Chattanooga, Tenn.
SECRETARY-TREAS.—A. R. McLAIN, 14 S. Brooks Ave., Chattanooga, Tenn.

CHICAGO — 3rd Fri.
CHAIRMAN—ERIC R. SEABLOOM, Crane Co., 836 S. Michigan Ave., Chicago, Ill.
SECRETARY—T. B. JEFFERSON, *The Welding Engineer*, 506 S. Wabash Ave., Chicago, Ill.

CINCINNATI, OHIO
CHAIRMAN—R. L. KIRBY, R.F.D. No. 1, Box 131, Sharonville, Ohio
SECRETARY—GEO. A. JACOBY, 1743 S. Derexa Drive, Hamilton, Ohio

CLEVELAND — 2nd Wed.
CHAIRMAN—R. J. KRIZ, James Herron Co., 1360 W. 3rd St., Cleveland, Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corp., Cleveland, Ohio

COLORADO — 3rd Wed.
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.

COLUMBUS, OHIO — 2nd Fri.
CHAIRMAN—CLAY W. ROBERTS, Pennsylvania R. R., Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT — 1st Tues.
CHAIRMAN—B. H. PERRY, Bigelow-Sanford Carpet Co., Thompsonville, Conn.
SECRETARY—J. IMPERATI, American Brass Co., Ansonia, Conn.

DETROIT — 1st Fri.
CHAIRMAN—EARL H. FOSS, 7239 Kentucky Ave., Dearborn, Mich.
SECRETARY—G. N. SIEGER, S-M-S Corp., 1165 Harper Ave., Detroit, Mich.

HAWAII — Last Thurs.
CHAIRMAN—GEORGE GLOVER, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANA — 3rd Fri.
CHAIRMAN—E. F. GILYEAT, J. D. Adams Mfg. Co., Indianapolis, Ind.
SECRETARY—H. D. WEED, P. R. Mallory & Co., Indianapolis, Ind.

KANSAS CITY, MO. — 1st Tues.
CHAIRMAN—EDGAR H. FINLAY, Finlay Engineering College, 1001 Indiana Ave., Kansas City, Mo.
SECRETARY—DUANE DE BRUNNER, Columbian Steel Tank Corp., 1509 W. 12th St., Kansas City, Mo.

LAKE SHORE
CHAIRMAN—FRED HERBST, JR., McMullen & Pitz Construction Co., 923 Commercial St., Manitowoc, Wis.

LOS ANGELES — 3rd Thurs.
CHAIRMAN—F. H. STEVENSON, Vega Aircraft Co., Burbank, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

LOUISIANA — 1st Fri.
CHAIRMAN—G. O. HUET, Higgins Industries, Inc., 1755 St. Charles Ave., New Orleans, La.
SECRETARY—A. E. ABAUNZA, Gulf Engineering Co., 916 Peters St., New Orleans, La.

MARYLAND — 3rd Fri., except April
CHAIRMAN—A. R. WYNN, 913 N. Hill Rd., Baltimore, Md.
SECRETARY—VAN RENSSELAER P. SAXE, 100 W. Monument St., Baltimore, Md.

MILWAUKEE — 3rd Fri.
CHAIRMAN—KEITH WALKER, 3721 S. Herman St., Milwaukee, Wis.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

NEW YORK — 2nd Tues, except when Joint Meeting is held
CHAIRMAN—G. SCHNEIDER, Acetylene Welding & Equip. Co., 1065 Atlantic Ave., Brooklyn, N. Y.
SECRETARY—GEORGE SYKES, The Linde Air Products Co., General Publicity Dept., 30 E. 42nd St., New York, N. Y.

NORTHWEST — 3rd Wed.
CHAIRMAN—JOHN MIKULAK, Electric Machinery Mfg. Co. 1331 Tyler St. N. E. Minneapolis, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

NORTHERN NEW JERSEY — 3rd Tues.
CHAIRMAN—T. B. SMITH, Federal Shipbuilding and Drydock Co., Kearny, N. J.
SECRETARY—W. H. HART, Chas. W. Krieg Co., 52-60 Dickerson St., Newark, N. J.

NORTHERN NEW YORK — Last Thurs.
CHAIRMAN—M. F. SAYRE, Union College, Schenectady, N. Y.
SECRETARY—R. S. PELTON, General Electric Co., Schenectady, N. Y.

OKLAHOMA CITY — First Thurs.
CHAIRMAN—FRANCIS SPREHE, Midwest Steel Co., 2 N. Indiana Ave., Oklahoma City, Okla.
SECRETARY—HOWARD N. SIMMS, Box 1714, Oklahoma City, Okla.

PEORIA—CENTRAL ILLINOIS
CHAIRMAN—CLIFFORD WIMMER, 1104 Ann St., Peoria, Ill.
SECRETARY—A. RUNKEL, R. G. LeTourneau, Inc., Peoria, Ill.

PHILADELPHIA — 3rd Mon.
CHAIRMAN—H. W. PIERCE, New York Shipbuilding Corp., Camden, N. J.
SECRETARY—H. CARRY BOSS, 248 Rhoads Ave., Haddonfield, N. J.

PITTSBURGH — Middle Wed.
CHAIRMAN—C. H. JENNINGS, Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros Co., 1201 House Bldg., Hays (7) Pittsburgh, Pa.

PUGET SOUND
CHAIRMAN—SYDNEY K. SMITH, American Bureau of Shipping, 1727 Exchange Bldg., Seattle, Wash.
SECRETARY-TREAS.—JOHN NELSON, Air Reduction Sales Co., 3623 E Marginal Way, Seattle, Wash.

ROCHESTER, N. Y. — 1st Thurs.
CHAIRMAN—EVERETT L. HAND, Gleason Works, 1000 University Ave., Rochester, N. Y.
SECRETARY—HAROLD J. KING, University of Rochester, Engineering Dept., Rochester, N. Y.

SAN FRANCISCO — Last Fri.
CHAIRMAN—ROBERT O. WALDMAN, Chicago Steel & Wire Co., 1043 Bryant St., San Francisco, Calif.
SECRETARY—R. E. LABAGH, Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

ST. LOUIS — 2nd Fri.
CHAIRMAN—A. S. SCHWARZ, John Nooter Boiler Works Co., St. Louis, Mo.
SECRETARY—H. C. CLOSE, Machinery & Welder Corp., 700 S. Spring Ave., St. Louis, Mo.

SAVANNAH
CHAIRMAN—L. W. ROBERTS, Little Burnside Island, Vernon View, Savannah, Ga.
SECY.-TREAS.—J. R. COWART, Southeastern Shipbuilding Corp., Savannah, Ga.

SOUTH TEXAS
CHAIRMAN—J. M. HUGHEN, Penn Shipyard, Inc., Beaumont, Tex.
SECRETARY-TREAS.—A. E. WISLER, Hughes Tool Company, 300 Hughes St., Houston, Texas.

TULSA, OKLA.
SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. — 2nd Tues.
CHAIRMAN—H. L. INGRAM, JR., Air Reduction Sales Co., 1823 L St., N. W., Washington, D. C.
SECRETARY—B. J. BRUGGE, 410 Hill Building, 17th and I Sts., N. W., Washington, D. C.

WESTERN NEW YORK — 3rd Fri.
CHAIRMAN—JOHN BOS, JR., 60 Westfield Rd., Eggertsville, N. Y.
SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

WESTERN MASSACHUSETTS
CHAIRMAN—WILLARD A. EMERY, Worthington Pump & Machinery Co., Holyoke, Mass.
SECRETARY—J. J. KAPINOS, Worthington Pump & Machinery Co., Holyoke, Mass.

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SECRETARY-TREAS.—R. L. TOWNSEND, 266 Minneapolis St., Wichita, Kan.

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CHAIRMAN—E. E. ROUSCHER, A. B. Farquhar Co., York, Pa.
SECRETARY—C. E. LEWIS KERCHNER, 290 W. Cottage Place, York, Pa.

YOUNGSTOWN, OHIO — 2nd Mon.
CHAIRMAN—ROBERT FISHER, 1534 Thomas Road, Warren, Ohio
SECRETARY—CARL J. HELTZEL, Heltzel Steel Form & Iron Co., Warren, Ohio.

THE AMERICAN WELDING SOCIETY

ACTIVITIES – RELATED EVENTS

PRESIDENT HANSEN HONORED

We reproduce herewith the program of a Testimonial Dinner given in honor of Klaus L. Hansen, President of the AMERICAN WELDING SOCIETY. The dinner was held in the Elizabethan Room of the Milwaukee Athletic Club, on Friday, April 30, 1943, at 7:00 P.M.

Procession of Guests.
Toastmaster—F. Salditt, Vice-President, Harnischfeger Corp.
Invocation—Rev. Lee Ferry, Westminster Presbyterian Church.
Dinner.
"Scholar, Professional Engineer, Citizen"—a biographical sketch of Klaus L. Hansen, by Dr. John D. Ball, Secretary and Past-President, Engineers' Society of Milwaukee.
Testimonial:
- Oscar Werwath, President, Milwaukee School of Engineering.
- Keith S. Walker, President, Milwaukee Section, A.W.S.
- Erwin Brekelbaum, Welding Superintendent, Harnischfeger Corp.
- F. W. Bush, Chairman, Milwaukee Section, A.I.E.E.
- W. J. Thuermann, President, Engineering Society of Milwaukee.
- Rudolph Hokanson, President, Milwaukee Association of Commerce.
- Karl O. Werwath, President, Wisconsin Junior Chamber of Commerce.
- W. E. Crawford, representing Dr. Comfort A. Adams, Philadelphia, Pa., Founder and Past-President of the A.W.S., Past-President of A.I.E.E.

Presentation of Testimonial: Carl J. Fechheimer, Consulting Engineer.
Response.
National Anthem—Dr. Herman Weil, accompanist.
Reception.

EXECUTIVE COMMITTEE MEETING AMERICAN WELDING SOCIETY

The Executive Committee Meeting of the A.W.S., was held in New York on March 25, 1943. The following were present: C. A. Adams, David Arnott, H. C. Boardman, R. W. Clark, W. E. Crawford, E. V. David, J. H. Deppeler, R. S. Donald, E. R. Fish, H. O. Hill, D. S. Jacobus, C. H. Jennings; Isaac Harter, member, Board of Directors; R. D. Thomas, *Chairman*, Section Advisory Committee; W. Spraragen, *Editor*, THE WELDING JOURNAL; M. M. Kelly, *Secretary*.

In opening the meeting, President Hansen reported that his health is improved, although not yet fully recovered. The Committee members expressed their pleasure in having Mr. Hansen present.

Appointments

A. Special Committee to study the desirability of building up A.W.S. reserve funds, with the following scope and personnel, was approved:

Scope.—To study the desirability of building up, at this time, the reserve funds of the A.W.S. If it is the opinion of the Committee that the time is appropriate for raising money for the purpose mentioned, the Committee to consider and recommend to the Board of Directors, plan of increasing the Society's reserve funds.

Personnel.—J. H. Critchett, O. B. J. Fraser, J. D. Gordon, Isaac Harter and A. C. Weigel.

B. Changes and additions to Membership Committee. On recommendation of the President, the resignation of Major J. D. Tebben as Chairman of the Membership Committee was accepted and the appointment of G. N. Sieger to this post was ratified. Further, on recommendation of the President, Mr. J. L. Stover was added to the Membership Committee.

Establishment of Adams Lecture

Consideration was given to proposal for establishment of this lectureship and after deliberation, it was, upon motion, duly seconded, unanimously voted:

> That a lectureship, covering some phase of the science of welding, to be given by an outstanding authority within his field, be established as a feature of the Annual Meeting of the SOCIETY;
>
> Further, that the lectureship be designated as "The Adams Lecture" in honor of the first President of the SOCIETY;
>
> Further, that Comfort A. Adams be designated as the lecturer for 1943; and
>
> Further, that a suitable certificate be presented to the lecturer as a token of appreciation and recognition of the author's prestige.

It was the consensus of opinion that since this lectureship is to be an annual award, it is within the province of the Awards Committee to nominate lecturers for future years. Preparation of regulations governing the awards and the selection of a suitable certificate for the lecturer was left in the hands of the Awards Committee.

1943 Annual Meeting

Progress on this Meeting was reported by the Convention Committee Chairman. On meeting arrangements, he stated that a meeting of the Convention Committee, with Chicago Section members, had been held in Chicago on February 19th, for the purpose of organizing activities and inspecting hotel space and facilities at the Morrison Hotel—selected tentatively as A.W.S. headquarters. Prior to this meeting, assurance had been given by Mr. Eisenman that there had been no change in plans for holding the 1943 National Metal Congress in Chicago the week of October 18th. The Chicago Section members are taking hold of arrangements enthusiastically so that we can look forward to a good Meeting.

On the technical program, the Program Committee Chairman reported that one meeting had been held to date. As a result of some 600 letters sent out, soliciting suggestions and ideas, a program of well worth while papers of direct interest to the war effort has been laid out. These have been divided into 18 sessions, simultaneously arranged to fit into a shortened 3½-day Meeting. Invitations have been extended to authors. It is planned to hold another meeting within the coming week, when consideration will be given to additional suggestions for papers received since the last meeting, and it is expected that the preliminary program will be published in the June issue of THE WELDING JOURNAL.

1942 Annual Meeting

The Convention Committee Chairman informed the Committee that the deficit on the 1942 Annual Meeting, reported at the last Executive Committee meeting, has since been written off due to the generosity of the welding manufacturers who, prior to 1942, exhibited in the National Metal Exposition but were unable to do so last year because of war conditions. The contributors were thanked.

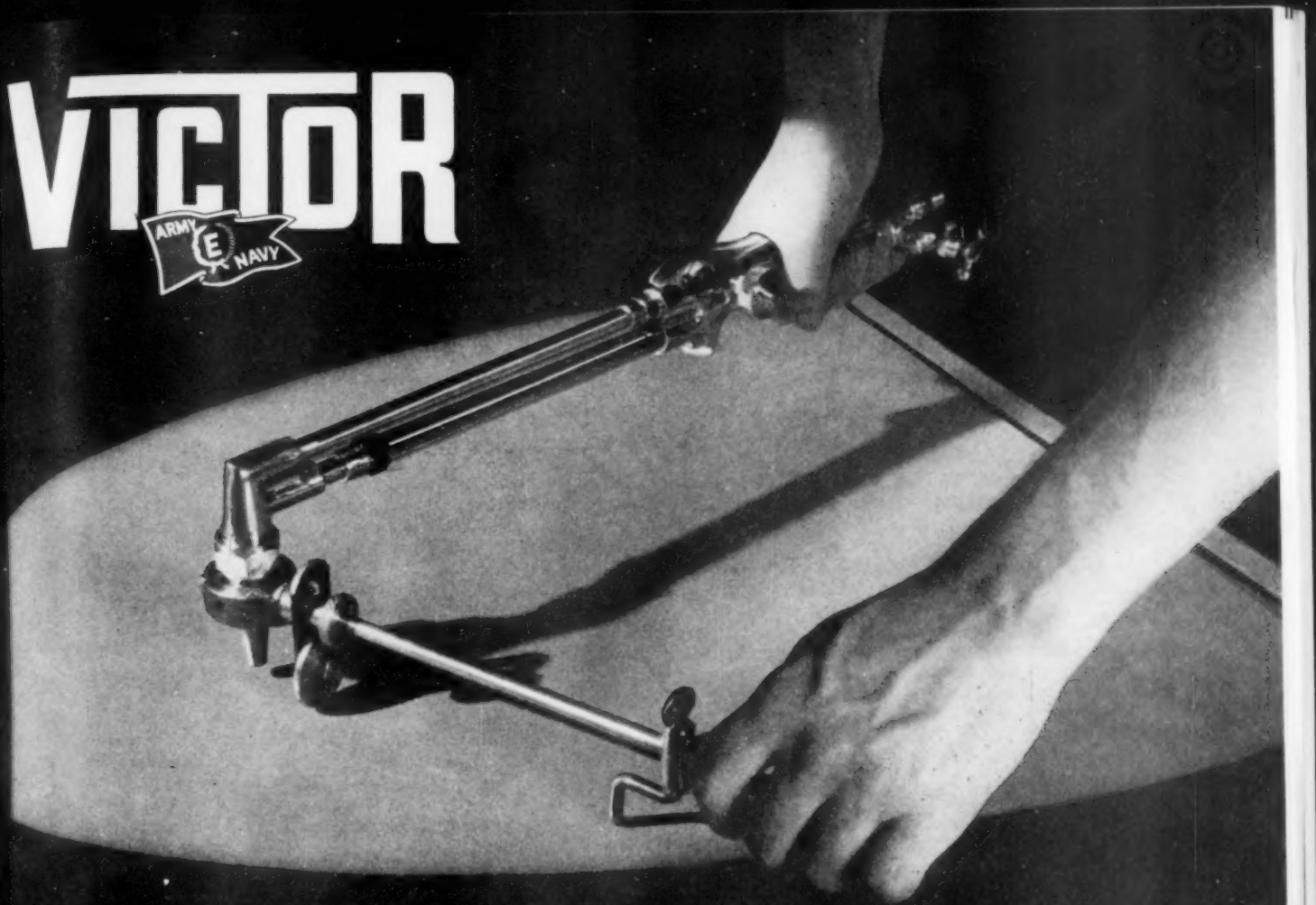
Outline of Work Committee

Proposed Amendment to American Standards Association Procedure.—Acting on recommendation of the Outline of Work Committee, it was voted that the A.W.S. go on record as favoring the elimination of the designation "American Recommended Practice" by the A.S.A. as provided for in the proposed amendment to A.S.A. Procedure, when letter ballot is submitted to the A.W.S.

Review of Activities.—In response to the question raised concerning the success of the present method of handling the SOCIETY'S technical work, Chairman Clark presented a résumé of present activities. He recalled actions taken last year to set aside for the duration of the war those activities of least importance because of the difficulty in getting work done unless it has a direct bearing on the war effort, and to set up procedures for preparing and issuing emergency standards. The Tentative Standards and Recommended Practices and Procedures for Spot Welding of Aluminum Alloys, prepared for the National Aircraft Standards Committee and issued as an emergency standard, was cited

VICTOR

ARMY E NAVY



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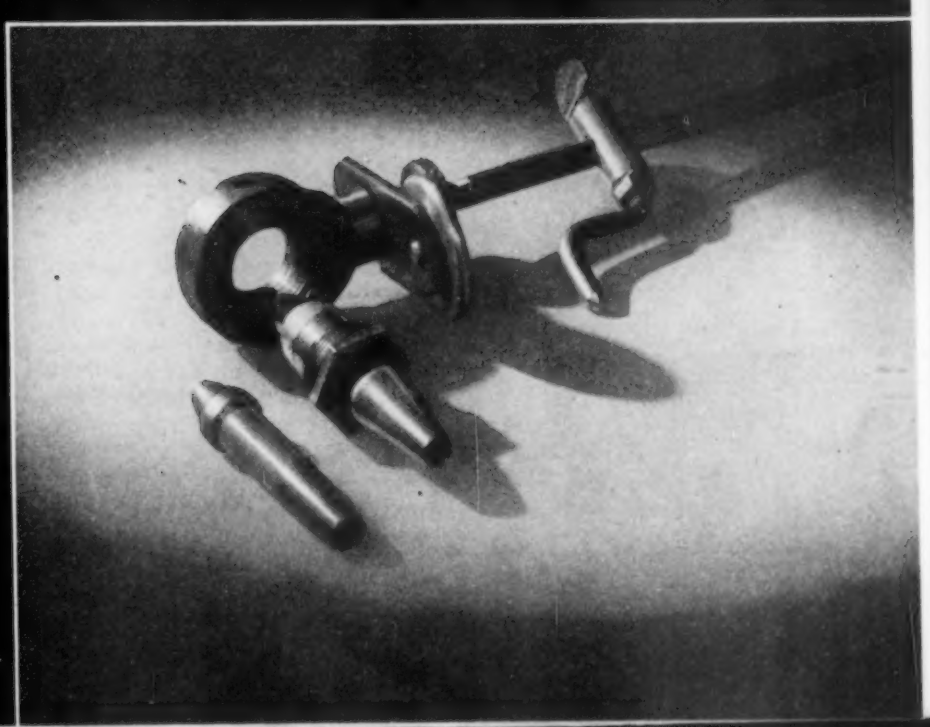

as an example. He told of the attempt being made to bring about cooperation between the Army Ordnance Department and the SOCIETY of the order that now exists between the Navy Department and NEMA. While he said there is nothing definite to report on this at the moment, he believes something will develop shortly.

Briefly he reported on present arrangement for cooperation with standardization committees of other organizations, whereby the AMERICAN WELDING SOCIETY confines its activities to setting up standards on welding and developing welding procedures that can be utilized as part of codes being prepared by other organizations.

Section Advisory Committee

Progress report on matters submitted to this Committee was presented by the Chairman.

He requested an expression of opinion as to the functions of this Committee which he believed to be that of liaison between the Sections and the Board of Directors, with responsibility to offer to the Board of Directors recommendations reflecting the majority of consensus of opinion of the Sections on matters referred to them. This, he stated, can only be done through correspondence which will clear through a central point, namely, the Chairman of the Section Advisory Committee. Members of that Committee are kept informed and given opportunity to comment through copies of letters sent to Sections. When sufficient response is had from the Sections, summary is prepared and definite recommendation formulated by the Chairman for the consideration of members of the Section Advisory Committee. After approval by that Committee, recommendation is passed on to the Board of Directors; if rejected, a meeting of the Committee is called. The procedure outlined by Chairman Thomas was approved.

Questions raised by Mr. Thomas is connection with proposals for consolidation of membership, SOCIETY districting, section boundaries and establishment of Student Chapters were discussed at some length and the following conclusions reached:

Consolidation of Membership.—That term "elimination of Operating member" should be discontinued as the intent of the proposal is to consolidate the Operating and Associate memberships into one classification, with annual dues of $10. Membership in the $5.00 grade is now limited to two years. Proposal merely means an expenditure of $10 on the part of the operator at the outset instead of after a two-year period. Associate membership is open to any individual interested in the science and art of welding.

Society Districting.—That proposal of Special Committee on districting of the SOCIETY for grouping the SOCIETY into seven geographic districts is acceptable, with suggested change of placing the Northern New Jersey Section in District No. 1—the New York, New England District.

Section Boundaries.—Proposal is that Section boundaries be determined by the Board of Directors and it is intended that these boundaries be set after consultation with the Sections concerned. No fixed radius is advisable but the boundaries should be such that the members residing within them are within easy traveling distance of the Section center. In the densely populated sections of the country, 25 miles seems to be an average distance, while in the less densely populated area, three or four times that mileage seems to be proper. It was the general feeling that no attempt should be made to have the whole country covered by Sections. There are places where Sections are not warranted and the scattered members in these remote parts do not benefit from any Section activity. Therefore, the Sections are not entitled to a return on the dues of such members.

A.W.S. MEMBERSHIP COMMITTEE MEETING

The Membership Committee held a meeting in New York on April 14th with G. N. Sieger, Chairman, presiding. It was agreed to prepare a revision of the pamphlet, "Progressing in Welding," which describes in excellent style the advantages of membership in the SOCIETY. Consideration was given to the preparation of a new membership application form to bring it in conformity with the applications of other societies, and, a

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of Course **PAGE**

MAKES ELECTRODES FOR WELDING ARMOR

PHOTO BY OFFICE OF WAR INFORMATION

When it was just beginning to be understood that adopting a welded construction could multiply America's tank output, **PAGE** developed its own electrode for welding Armor—just as **PAGE** also developed its range of electrodes for welding Stainless Steel, when little Stainless was being welded.

Only one electrode is necessary to weld Armor. But **PAGE**—in conjunction with America's largest producer of Stainless Steel—developed such a wide range of **PAGE** Allegheny **ELECTRODES** that from it the welder can choose the electrode that will deposit metal in the weld that equals whatever Stainless Steel he may be welding.

As you use electrodes in these days of scarcity, we continue to caution that these should be used carefully. Use electrodes of correct analysis and of most economical diameter. Encourage welders to deposit no extra metal in the weld and to use their electrodes right to the holder.

PAGE

WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION

Monessen, Pa., Atlanta, Chicago, New York, Pittsburgh, San Francisco, Portland

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ESSENTIAL PRODUCTS . . . TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, Yacht Rigging, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*

the same time, supply the information needed by the SOCIETY. It was agreed that further effort should be made to induce some of the leading companies to mail out a special four-page leaflet with an application blank, entitled "Advance with Welding."

Special preparations were made for advertising the value of membership in the three welding publications. These ads were prepared through the courtesy of the advertising departments of the P. R. Mallory Company, The Lincoln Electric Company and the Metal and Thermit Corporation.

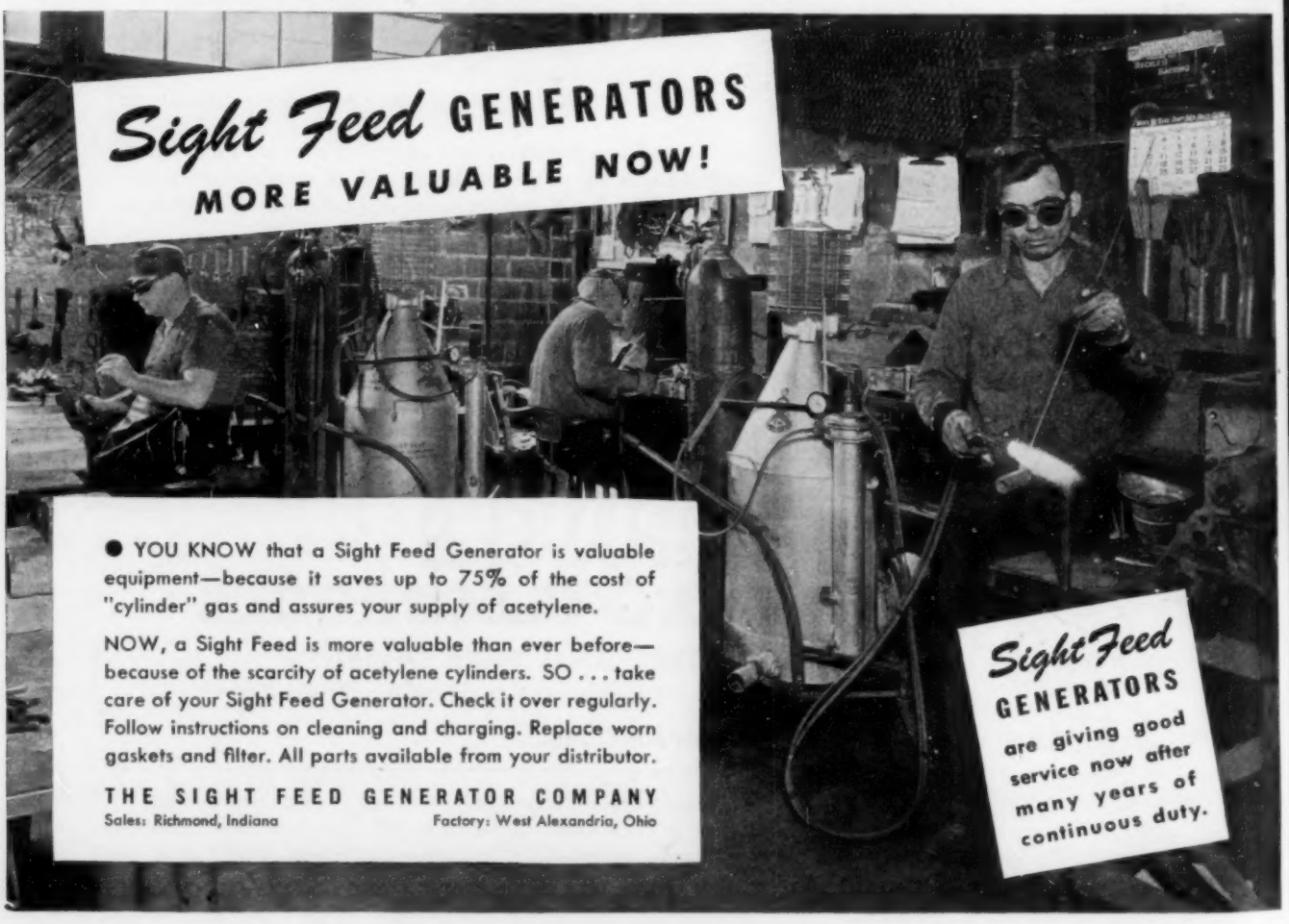
It was proposed that Headquarters provide and mail with the national election ballot, a brief statement of the year's accomplishments and an invitation to members to submit the names of friends in the form of nominations for membership. It was agreed that the greatest contribution which the SOCIETY could make to the welfare of the Sections was assistance in securing good speakers for Section meeting. The National Secretary, Miss M. M. Kelly, reported that a new list of available speakers was being made up and would soon be ready for distribution.

Courtesy Westinghouse Electric & Manufacturing Company

Welding the Outside Frame of a 60,000 Kilowatt Hydrogen-Cooled Generator

NAVAL ARCHITECTS MEET

The New York Metropolitan Section of the Society of Naval Architects and Marine Engineers was launched at the Downtown Athletic Club, May 6th. It is interesting to note that the speaker selected for the opening meeting was J. Lyell Wilson, member of the AMERICAN WELDING SOCIETY and Assistant Chief Surveyor of the American Bureau of Shipping. Mr. Wilson discussed details of design for welding in ship construction. There was a record attendance of more than 500. The paper was well received and considerable discussion aroused. Among those discussing Mr. Wilson's paper were Prof. Otto Henry of Brooklyn Polytechnic Institute and W. Spraragen, Editor of THE WELDING JOURNAL.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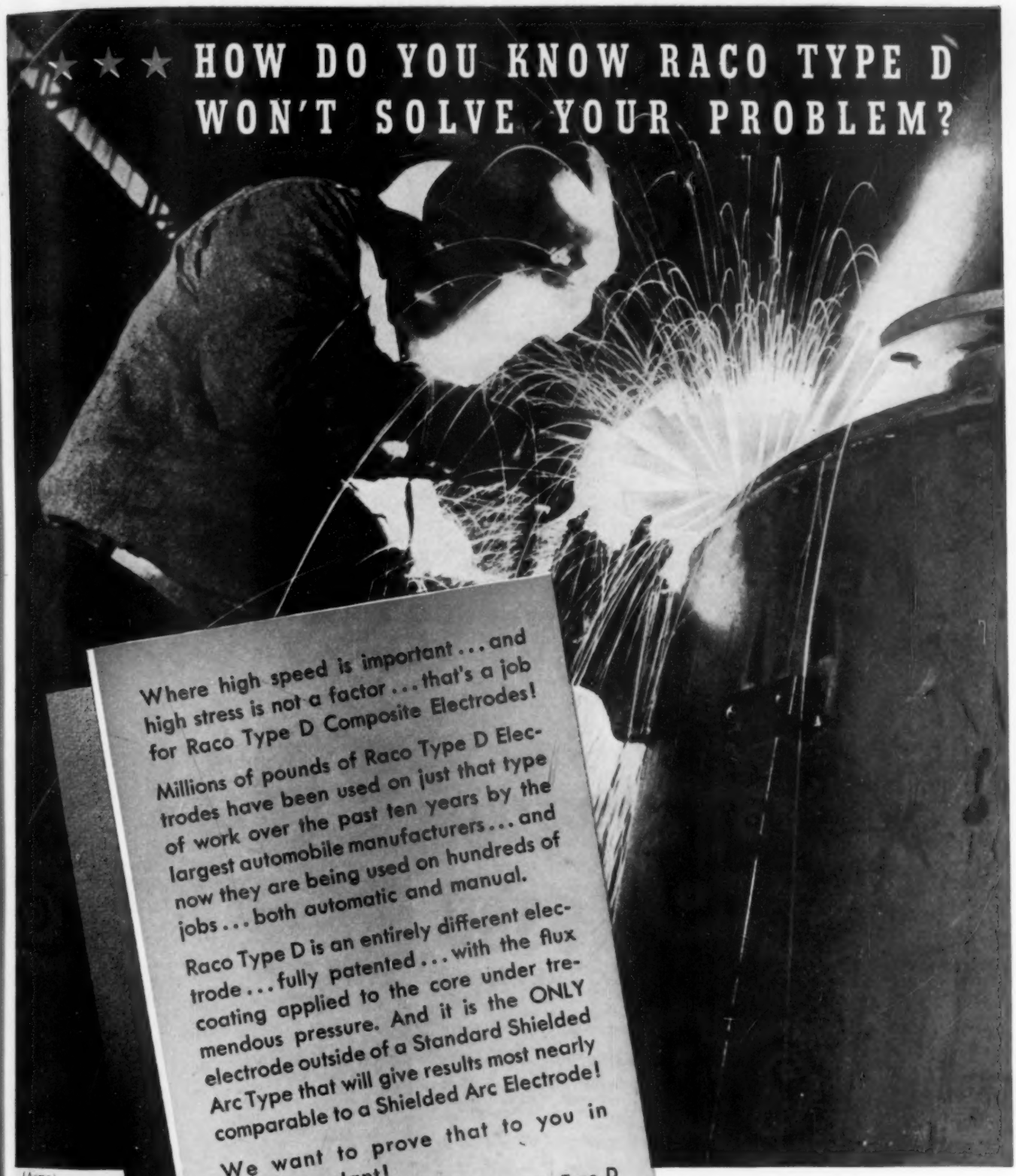
Sight Feed GENERATORS are giving good service now after many years of continuous duty.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Where high speed is important . . . and high stress is not a factor . . . that's a job for Raco Type D Composite Electrodes!
Millions of pounds of Raco Type D Electrodes have been used on just that type of work over the past ten years by the largest automobile manufacturers . . . and now they are being used on hundreds of jobs . . . both automatic and manual.
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MAKERS OF

Raco Type HD Shielded Arc Electrodes for Stainless Steel, Mild Steel • Raco Type M and Type D Light Coated Electrodes for Manual and Automatic Work • Samples and Literature on request.

BUSINESS AT WAR

In its May issue, *Fortune* under the above heading devotes a section on welding. Quoting *Fortune:* "Welding, after a brawling youth, comes of age in the shipyards of war."

BRAZING WITH PHOS-COPPER DISCUSSED IN NEW BOOKLET

How to braze with Phos-Copper, brazing alloy which saves time, machines and man power and can be used with gas, incandescent carbon, electric furnace and dip brazing methods is discussed in a new booklet announced by Westinghouse Electric & Mfg. Co.

The new 12-page booklet contains hints on good brazing and proper joint designs. Butt, scarf, shear and lap joints are considered, and diagrams show proper designs.

Phos-Copper is free-flowing at 1382°F., so heating time is shortened. Machining of the finished joint is not necessary in most cases. Among the advantages of Phos-Copper listed in the booklet are its low melting point, uniformity of brazing material, high tensile strength and stress cycle, 98% electrical conductivity of joint. It resists corrosion, can be tinned or electric-plated.

Phos-Copper is available in rod and ribbon form, and in special shapes for "tong" and furnace brazing.

A copy of booklet B-3201 may be secured from Department 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., or from the nearest Westinghouse office.

SUMMERILL BULLETIN NO. 443

Summerill Tubing Co., Bridgeport, Pa., has just issued a new 12-page booklet on tubing identified as Bulletin No. 443. It is a war edition with a great deal of useful information on the many specialties Summerill is producing, including tapered and formed tubes and a wide variety of special shapes. It also has a Guide Chart giving rather complete detailed information on the chemical composition of twenty-five different metals in regular production, together with size range available for each and mechanical properties and physical properties which should be a useful reference in the hands of all men interested in design and use of materials. It is available on request—business letterhead preferred.

SPACKMAN HEADS OPERATIONS AT LUKENS

G. Donald Spackman has been elected vice-president in charge of operations of Lukens Steel Co., it was announced

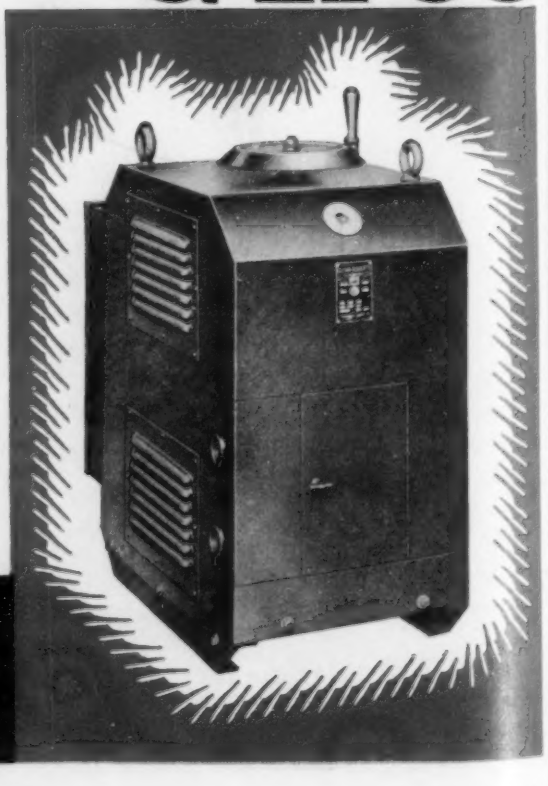
recently by Robert W. Wolcott, Lukens' president.

Since January 6, 1941, Mr. Spackman had been general manager of Lukens Steel Co. and its subsidiaries, By-Products Steel Corp. and Lukenweld, Inc. In his new capacity as vice-president in charge of operations, Mr. Spackman will be responsible for the over-all operations of the three companies, and their coordination for maximum production for the war effort in which the three companies are exclusively engaged.

Now...AN INDUSTRIAL

G-R 38

300 AMPERE G-R WELDER
(RANGE 70-420 AMPERES)
FOR ONLY $380
***with* POWER FACTOR CORRECTION**



Extensive demand for this reliable heavy-duty G-R Welder permits a substantial price reduction, creating at $380 (with power factor correction) a peak value in industrial welders. G-R 38, built for sustained welding loads, has earned an important place in shipyards and industrial plants wherever the welding of medium or heavy thickness metal is carried on.

This machine is characterized by exceptional welding characteristics throughout its range. *Stepless Control*...high efficiency ...power factor correction...and safety for the operator are other G-R advantages.

GLENN-ROBERTS COMPANY
1009 FRUITVALE AVENUE, OAKLAND, CALIFORNIA
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P. O. Box 1814, Washington, D. C.

THE GALVANIC SERIES Studies of galvanic corrosion have made it possible to arrange metals in a Galvanic Series which shows the tendencies of metals and alloys to form significant galvanic cells and the probable direction of the galvanic effects.

Within this Series the metals and alloys may be divided into groups. Those grouped together have no strong tendency to produce galvanic corrosion of each other and therefore are relatively safe to use in contact with each other unless the area of the less noble is markedly smaller and the metals are near the opposite ends of the group. The coupling of two metals from different groups and distant from each other in the list will frequently result in galvanic, or accelerated, corrosion of the less noble metal. The farther apart the metals stand in the Series, the greater will be the galvanic tendency.

Obviously, at the present time, the Galvanic Series becomes even more useful as a guide in untried combinations made necessary by metal shortages. Although the arrangement of metals in the Series is based on results of experiments and practical experience involving many common corrosives, it cannot replace the need for tests when unusual corrosives are encountered or other unusual conditions prevail that may cause major shifts of the relative positions of metals in the Galvanic Series.

Galvanic Corrosion...

7 Avoid joining materials well apart in the series by threaded connections, as the threads will probably deteriorate excessively. Brazed joints are preferred when using a brazing alloy more noble than at least one of the metals to be joined.

8 Whenever possible, install relatively small replaceable sections of the less noble material at joints and increase the thickness of the less noble material in such regions; for example, by using extra heavy wall nipples in piping or by attaching replaceable pads in the vicinity of the galvanic contact.

9 Install pieces of bare zinc or steel so as to provide a counteracting galvanic protection effect that will suppress galvanic corrosion.

INCO's Technical Service is prepared to assist metal users in solving galvanic corrosion problems. Available data from INCO's Corrosion Files for a particular combination of metals will be furnished wherever possible. Aid can also be extended in applying general principles to specific problems.

As a first step in securing INCO's help on a specific corrosion problem, write for a copy of the Corrosion Data Work Sheet.

GALVANIC SERIES

Corroded End (anodic, or least noble)

Magnesium
Magnesium alloys

Zinc

Aluminum 2 S

Cadmium

Aluminum 17 ST

Steel or Iron
Cast Iron

Chromium-iron (active)

Ni-Resist

18-8 Stainless (active)
18-8-3 Stainless (active)

Lead-tin solders
Lead
Tin

Nickel (active)
Inconel (active)

Brasses
Copper
Bronzes
Copper-nickel alloys
Monel

Silver solder

Nickel (passive)
Inconel (passive)

Chromium-iron (passive)
18-8 Stainless (passive)
18-8-3 Stainless (passive)

Silver

Graphite
Gold
Platinum

Protected End (cathodic, or most noble)

EFFECT OF ANODE AND CATHODE AREAS

In any galvanic combination the relative areas of the two materials forming the couple have a very important bearing on the extent of corrosion. Under many conditions the extent of galvanic effect will be very nearly proportional to the ratio of the area of the more noble metal to the area of the less noble metal.

Thus, if a piece of steel having a surface area of two square inches is coupled to a piece of copper having a surface area of one hundred square inches the galvanic corrosion is roughly twenty-five times faster than it would be if the same piece of steel were coupled to a piece of copper having a surface area of two square inches.

For this reason it is wise to avoid galvanic couples where the exposed area of the metal lower in the Galvanic Series is much greater than that of the metal higher in the Series. As a practical example, it would be definitely dangerous to use a steel rivet in a Monel plate, but reasonably safe to use a Monel rivet in a steel plate.

OTHER FACTORS INFLUENCING GALVANIC CORROSION

Many factors, in addition to the two cited, influence the intensity and distribution of galvanic corrosion, some of these factors are more important than others from the standpoint of precautionary measures.

One of the more important factors is the conductivity of the complete circuit. Since the voltages developed are very low, any permissible practice that increases the resistance or interrupts the circuit, minimizes or eliminates galvanic action. Partial or complete insulation of the metals at their points of contact or connection is very effective. Reduction of the amount of dissolved oxygen is another factor through which galvanic action can be retarded. During corrosion, hydrogen collects on the surface of the lesser attacked metal and in effect acts as an insulator in suppressing corrosive action on the more attacked surface. Since any action or material that removes the hydrogen film allows the corrosive action to continue and because oxygen tends to combine with newly formed (nascent) hydrogen and remove it as water, the presence of dissolved air (oxygen) should be avoided or limited as much as possible.

67 Wall Street • New York, N. Y.

Mr. Spackman was born on June 29, 1895, at Coatesville, Pa., and attended Coatesville High School and Swarthmore College, graduating from the latter in 1917 with the degree of Bachelor of Arts. His Mechanical Engineering degree was awarded in 1924 by Swarthmore.

In 1917, Mr. Spackman joined Lukens, serving in the Mechanical Department and handling steam, hydraulic and combustion problems. In December 1920, he was appointed fuel engineer for the company, serving in that capacity until August 1925 when he was appointed superintendent of the Flanging Department.

In August 1929, Mr. Spackman was appointed asst. general superintendent of Lukens. When Lukenweld, Inc., was formed in May 1930, Mr. Spackman was elected president of Lukenweld. In September 1936, Mr. Spackman was appointed general supt. of Lukens.

Mr. Spackman is a director of the National Bank of Coatesville and the Atlantic Ice Manufacturing Co. He is chairman of the Coatesville branch of the American Red Cross. He is a member of the Racquet Club of Philadelphia, the American Society of Mechanical Engineers and the American Iron and Steel Institute.

SECOND BIRTHDAY FOR MILLION-VOLT INDUSTRIAL X-RAYS

April 1st marked the second anniversary of the pioneer installation of 1,000,000-volt industrial X-rays. On that day the equipment in the X-ray laboratory of the main works of the General Electric Company had built up a record of more than 45,000 radiographs of heavy castings and forgings, involving more than 8,000,000 lb. of metal. Particularly noteworthy in establishing the two-year record was the fact that the original X-ray tube had never needed replacement, despite its around-the-clock schedule. At the end of its second year it had operated more than 1400 hr, with some exposures as short as one minute and with some as long as $1^1/_2$ hr.

Material examined with the pioneer equipment has included castings as much as 8 in. thick. Among the faults revealed by the X-rays have been blowholes, tears, shrinkage cavities, inclusions and cracks—faults which would not be detected by the keenest of eyes and which could not be tolerated in high-pressure turbine casings, or ordnance equipment. Steels and ferrous alloys of many kinds were inspected, as were welded structures and thick aluminum alloys. While X-rays at considerably lower voltage could have been used for these aluminum parts, use of 1,000,000 volts has given better pictures, especially in the case of castings of irregular shape and variable thickness. In addition, the higher penetrating power makes it possible to increase the distance between the object and the tube and so reduce geometrical distortion resulting from the spreading of the rays. From a greater distance, they are more nearly parallel.

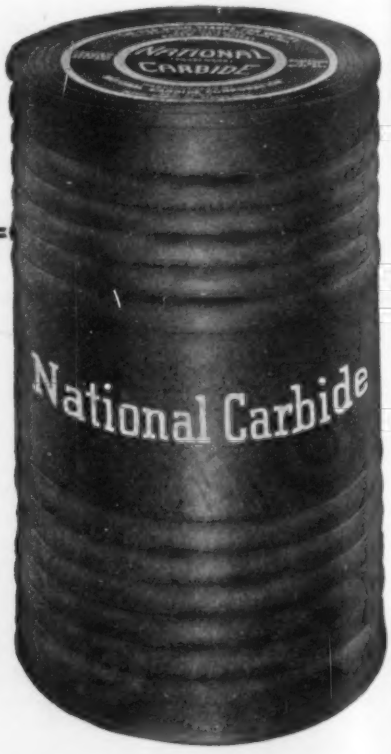
ARMSTRONG JOINS WAR METALLURGY COMMITTEE

Thomas N. Armstrong, metallurgist with the Development Research Department of the International Nickel Co. since 1935, is now also a part-time member of the staff of the War Metallurgy Committee of the National Academy of Sciences, National Research Council. Mr. Armstrong graduated from the University of Kentucky in 1927 with a degree in Metallurgical Engineering and was employed by the Andrews Steel Co., Newport, Ky., and as metallurgist in the Norfolk Navy Yard, Portsmouth, Va., before joining the staff of the International Nickel Co. His activities and professional interests have included alloy steels, ordnance and welding. With Mr. H. J. French, he received in 1940, the Lincoln Gold Medal Award of the AMERICAN WELDING SOCIETY for his paper with French entitled "Weld Hardening of Carbon and of Alloy Steel." Mr. Armstrong is a member of the American Foundrymen's Association, American Society for Metals, American Society for Testing Materials and Army Ordnance Association.

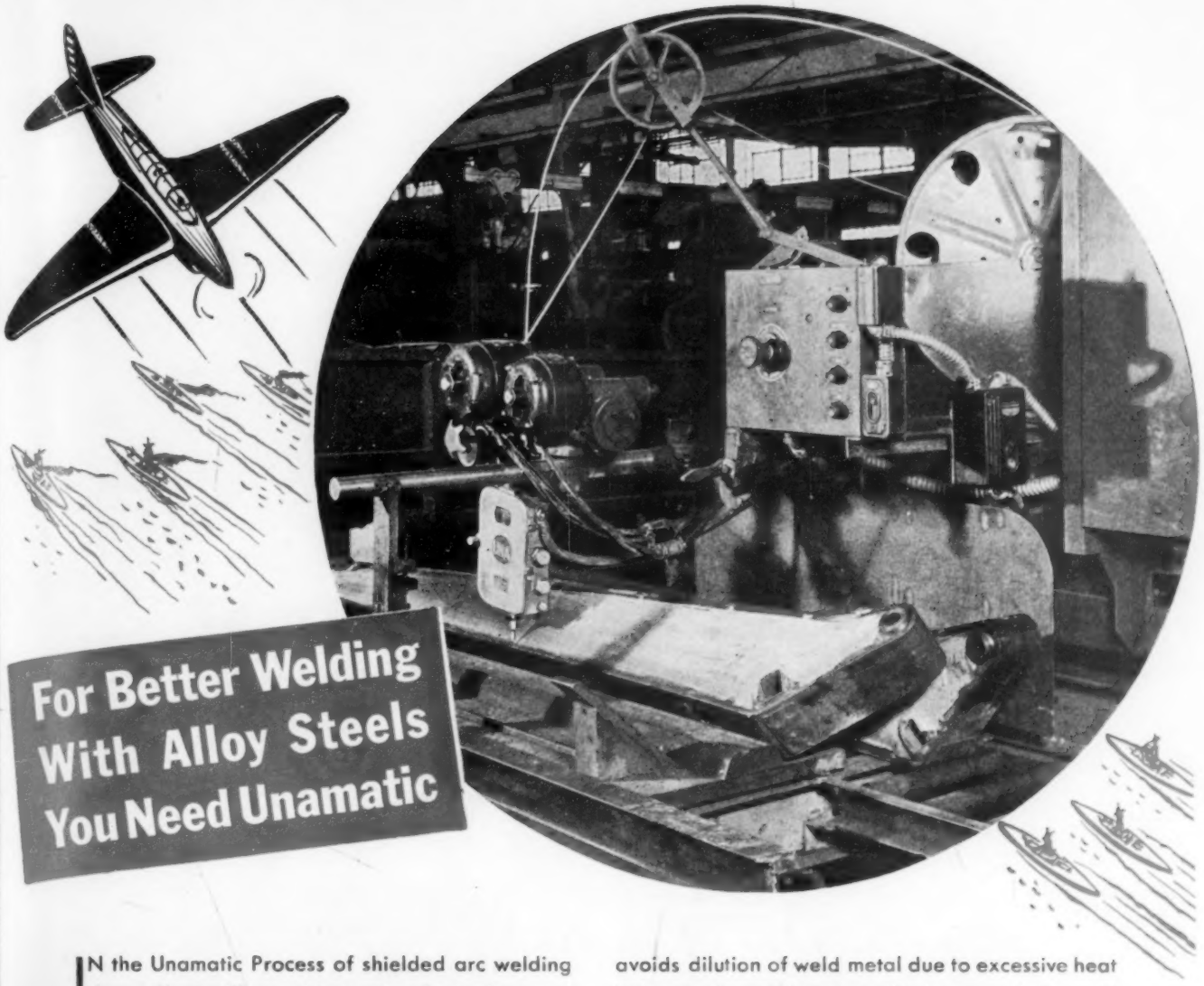
Mr. Armstrong's work for the International Nickel Co. on the development of alloy steels, as well as his earlier metallurgical work at the Norfolk Navy Yard, particularly fits him for his assignments in his new position as a Research Supervisor for the War Metallurgy Committee. His principal responsibilities are the direc-

National
Carbide
IN THE RED DRUM

EFFICIENT
ECONOMICAL
DEPENDABLE



FOR WELDING and CUTTING
Use National Carbide in the Red Drum
60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.



For Better Welding With Alloy Steels You Need Unamatic

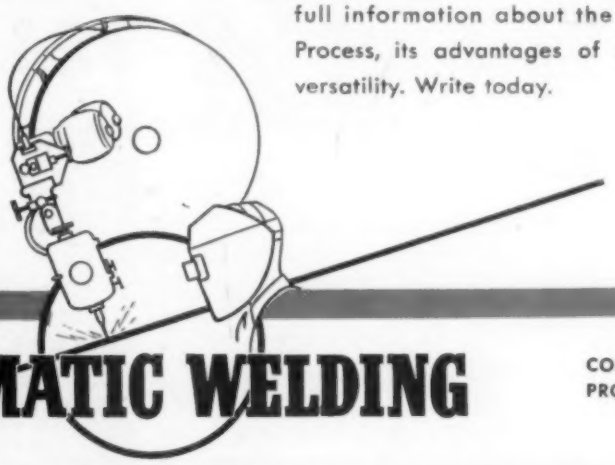
IN the Unamatic Process of shielded arc welding lower heat with consistent rate of travel prevent concentration of stresses which is the cause of buckling in high tensile and alloy, especially stainless, steels.

The close control of all variables, which is the outstanding principle of Unamatic welding, is the reason for the uniformly better welds obtained by Unamatic users with special steels.

The Unamatic Process using low heat and multiple passes not only avoids dilution of weld metal due to excessive heat but anneals and improves the texture of the weld metal and thus insures maximum strength in the weld.

As alloy electrodes cost up to a dollar or more per pound the elimination of stub ends is both a very important saving in cost and a conservation of critical materials.

If you are considering automatic welding get full information about the Unamatic Process, its advantages of range and versatility. Write today.



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tion of research on steel foundry products and on the low temperature properties of metals. These are two of the major fields in which the War Metallurgy Committee is directing metallurgical research projects on instruments of warfare for the National Defense Research Committee of the Office of Scientific Research and Development, and on metal production problems for the Office of Production Research and Development of the War Production Board.

PROGRESSIVE VICE-PRESIDENT

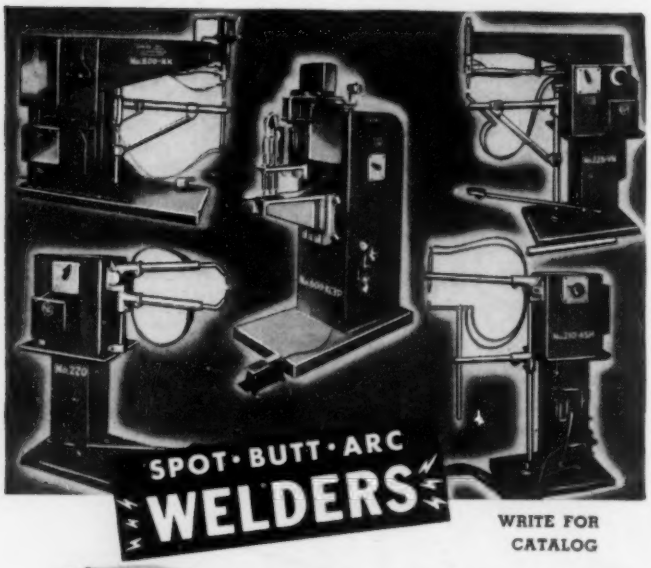
Announcement has been made of the appointment by the Board of Directors of T. M. Cummings as executive vice-president and general manager of Progressive Welder Co., Detroit.

Mr. Cummings, who has been vice-president of Progressive since the company was founded, attended Bucknell University and obtained his early experience in resistance welding in the automotive industry. In 1933 he helped organize Progressive Welder Co. and for the first year was in charge of manufacturing and engineering development. With manufacturing and engineering divisions organized, Mr. Cummings was placed in charge of sales development for the company and is credited with much of the tremendous development that has raised Progressive Welder Co. in only a few years from an unknown organization to one of the most important producers in the welding field.

As executive vice-president and general manager, Mr. Cummings will be in complete charge of all operations of Progressive Welder Co. according to the announcement.

AMMUNITION FOR INDUSTRY

The ammunition being turned out by the workman, in the accompanying illustration, is not a load of bombs but electronic tubes produced at the Westinghouse Lamp Division, Bloomfield, N.J., to supply power for aluminum production. Called ignitrons, the metal-encased devices convert alternating current into direct current needed to make aluminum for American fighting planes. The workman is shown seam welding the metal jacket in which the tube mechanism is enclosed.



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WE INVITE CONTRACT SPOT WELDING IN LARGE OR SMALL QUANTITIES.

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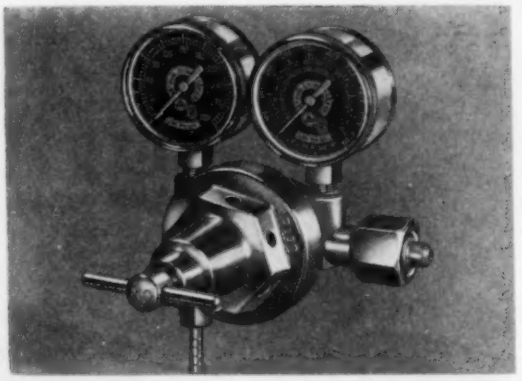

BRASS MAKES BULLETS

REGO

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REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

Conserve equipment—You may not get more.

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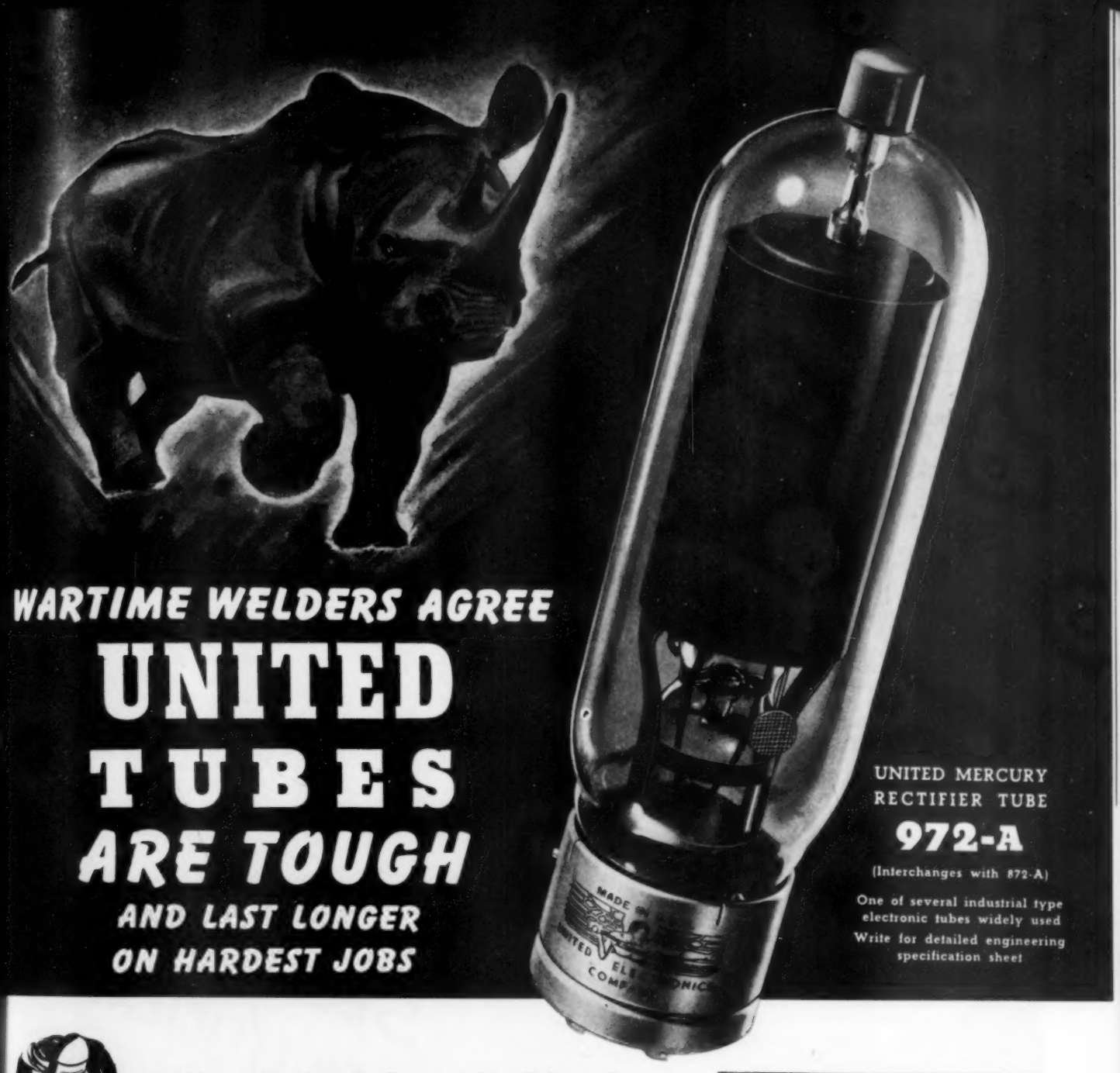
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases



WARTIME WELDERS AGREE

UNITED TUBES ARE TOUGH

AND LAST LONGER ON HARDEST JOBS

UNITED MERCURY RECTIFIER TUBE

972-A

(Interchanges with 872-A)

One of several industrial type electronic tubes widely used

Write for detailed engineering specification sheet

In shipyards, aircraft plants and tank factories—wherever toughest welding jobs are done—United 972-A's are loyal overtime workers.

On these tough proving grounds more and more engineers are choosing United tubes... for demonstrated high efficiency plus longer life.

It's an extra margin of ruggedness that makes each United 972-A last longer in use. Test after test proves that these finer tubes can "take it" under severe vibration and shock.

If you have not yet standardized on UNITED tubes for resistance welding, we suggest that you try them for your next replacement needs.

WHY UNITED INSURES LONG SERVICE LIFE

1. The protruded filament surface, mounted on a vertical plane, affords increased emitting area, while adding to the rigidity of the filament.
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NEWARK NEW JERSEY

WELDING FLUXES FOR THE AIRCRAFT INDUSTRY

An attractive folder has been issued by the Superior Flux Co., Public Square Building, Cleveland, Ohio, describing their four fluxes for the aircraft industry. These include: No. 6—for brazing and silver soldering all metals except aluminum; No. 7—for welding stainless steel and Monel; No. 8—for welding Inconel; No. 9—for welding aluminum and its alloys.

NATIONAL EMERGENCY STEELS

An unusually informative pamphlet has been prepared by the American Society for Metals, 7301 Euclid Ave., Cleveland, Ohio, on the National Emergency Steels and their use, including welding. Price 50 cents.

OXYGEN SHORTAGE

The present shortage of industrial oxygen will continue until early 1944, when it is expected that new plant facilities should be completed, it was stated at a meeting of the Oxygen and Acetylene Industry Advisory Committee held recently in Washington.

The present shortage of calcium carbide, now under allocation, probably will prevail throughout 1943, the committee was told. However, several new production facilities are scheduled for completion during the next few months.

War needs for acetylene, a gas generated from calcium carbide, and demands for oxygen continue on a peak basis and it is imperative that all consumers of these gases adopt rigid conservation measures, it was pointed out.

The committee was informed that considerable difficulty still is being experienced in obtaining sufficient carbide in one-quarter size, and an investigation will be conducted on the possibility of converting generators consuming this size to utilize a size in better supply. The crushing of calcium carbide to obtain one-quarter size results in a large quantity of dust which presents a difficult disposal problem.

April allocations of calcium carbide were made with the objective of eliminating cross hauling wherever possible and it is estimated that a saving in transportation of several million ton miles is being effected.

The report of a task committee relative to changes in specifications of calcium carbide was submitted at the meeting. It is expected that a new wartime specification will be approved in the near future which will be less stringent than the present federal specifications. The necessity for this change was occasioned by the fact that suitable raw materials for the production of calcium carbide cannot be obtained at present in all sections of the country.

MANUFACTURER OF BEER TANKS CUTS COSTS BY CHANGING TO LARGER SIZE ELECTRODES

A saving of 13 lb. of weld metal per foot and an increase in welding speed of 6 ft. per hour was obtained by Wm. Bros Boiler and Manufacturing Co. of Minneapolis, Minn., through adoption of larger size electrodes, according to The Lincoln Electric Co., Cleveland, Ohio.

In addition to the savings of weld metal and the increase in welding speed, the boiler manufacturer reports other advantages including elimination of beveling, cleaning between beads and chipping out of the root bead without any sacrifice in quality.

The work involved is in production of beer tanks, which had to meet requirements of the A.S.M.E. Boiler Code. The tanks were 13 ft. in diameter, 13 ft. 7 in. long and constructed of $^{5}/_{16}$-in. boiler plate. The work was completed about a year ago and has been in successful operation.

Former procedure consisted of beveling plates 30° with a $^{1}/_{16}$-in. root opening. The first pass was made with $^{5}/_{32}$-in. E-6010 (AMERICAN WELDING SOCIETY classification) electrode at 130 amp. followed by a second pass using $^{3}/_{16}$-in. size of the same electrode at 175 amp. The root of the weld was then chipped out and a single pass made on the inside with $^{3}/_{16}$-in. E-6010 electrode at 175 amp. This required 0.37 lb. of electrode per

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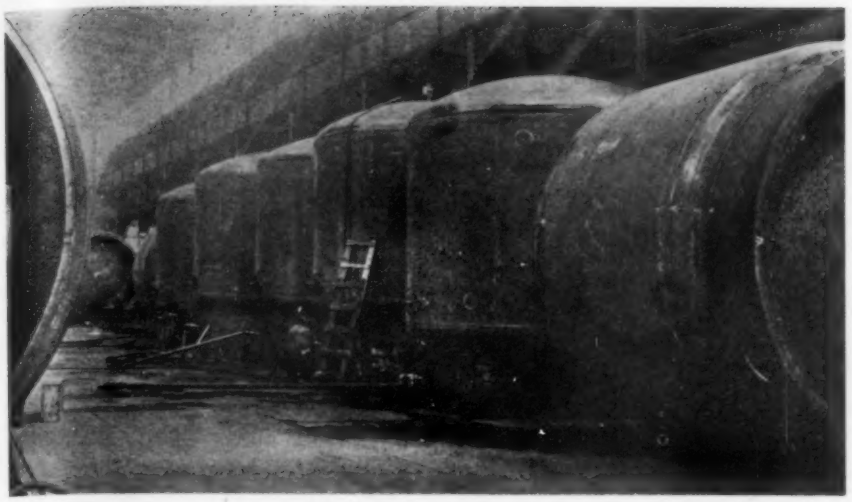


Use of Larger Size Electrodes Saves 0.13 Pounds of Weld Metal per Foot of Weld and Increases Welding Speed by 6 Feet per Hour in Production of These Beer Tanks

foot of weld. The joint was welded from both sides and the rate of welding was 5 ft. per hour for a completed weld.

In the new procedure, a square butt joint with $^1/_{16}$-in. opening but without bevel is used on the $^5/_{16}$-in. plate. The first pass is welded on the inside using $^1/_{16}$-in. E-6030 electrode at 220 amp. The second pass is welded on the outside using $^1/_4$-in. E-6010 electrode at 275 amps. A total of 0.24 lb. of electrode is used per foot of weld. The rate of welding, both sides, is 11 ft. per hour for the completed weld.

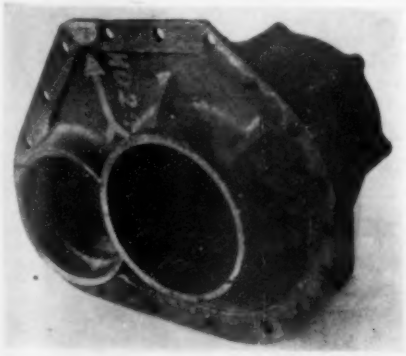
The operators were qualified in accordance with A.S.M.E. requirements and the work inspected by Fidelity Casualty Insurance Co.

The accompanying illustration shows a collection of beer tanks at Wm. Bros. Boiler and Manufacturing Co.

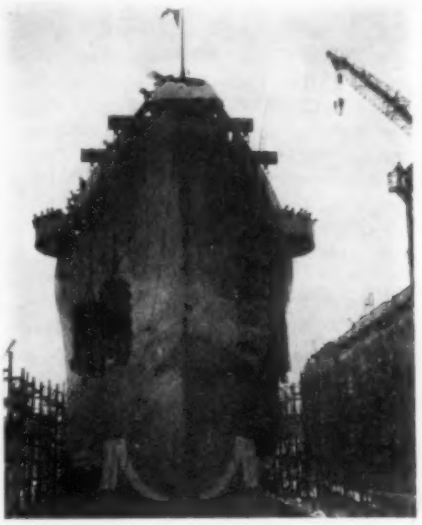
WELDING CAST IRON

An interesting pamphlet has been published on the subject by the Eutectic Welding Alloys Co., 40 Worth St., New York City.

The process is a low-temperature welding operation by which alloys having a close matching composition with the parent metal are applied with a technique similar to brazing. The advantages of being able to operate at low temperatures are obvious because of the fact that less heat is used, delicate or machined castings will not warp and no stresses will be created. The parent metal will not be affected by high temperatures, as it is only heated moderately, thus its physical properties of the metals are unchanged. Structure changes in particular are avoided. The operation is simple—it consists of chamfering or chipping out the defect, applying a specially developed flux, heating up the neighborhood of the defect with an oxyacetylene torch.



Low Temperature Cast Iron Repair



19TH SHIP IN LESS THAN 5 MONTHS

Tampa Shipbuilding Co. launched the U.S.S. *Mauna Loa* on April 14th, the 19th ship launched by Tasco in less than five months, starting with a mass launching of seven ships on December 7th, the anniversary of Pearl Harbor Day.

The above ship is an ammunition carrier for the U. S. Navy.

HEAT TREATMENT OF METALS

Heat Treatment of Metals, by J. Winning, Dipl. R.T.C. Fully illustrated. Price $1.50. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y.

For some years past there has been an

WESTINGHOUSE A-C WELDERS

for use with the

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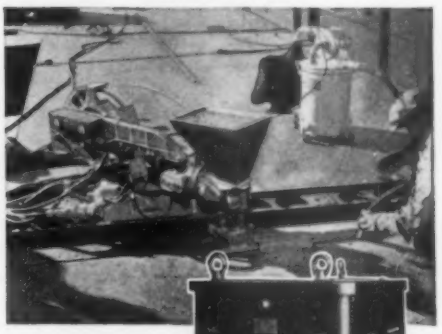

5 REASONS

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1 Westinghouse transformer equipment is specially designed for use with the Unionmelt welding head.

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The Unionmelt Welding Process is the fastest known method of making butt, fillet, and plug welds—up to 20 times faster than any other method. Working together, Unionmelt equipment and Westinghouse A-C Welders form a team that will give you faster continuous production at a new low cost. Write for full details—ask for Booklet B-3090. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pennsylvania. J-90470

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ever-increasing need, rendered more acute by present war conditions, for some means of bridging the gap between theoretical developments and their practical application.

This book was written in order to give a condensed yet complete, logical account of modern heat-treating methods, along with the underlying principles on which they were based.

This book can give valuable assistance to the reader on unfamiliar ground. It is of particular value to engineers and others who, while not being specialists in metallurgy, make contact with heat treatment and its problems in their everyday work.

X-RAY COMPANY EARNS ARMY-NAVY "E"

The "know how" processes of research and ingenuity involving practical substitutes for critical metals developed by management, engineers and workers of the Kelley-Koett Mfg. Co., Covington, producers of X-ray equipment has won commendation of the Surgeon-General Office of the War Dept. in conjunction with the Army-Navy "E" Award merited by the plant recently.

Brigadier-General C. C. Hillman, acting Surgeon-General complimenting the Kelley-Koett organization for winning the "E" for production achievement, wrote A. H. Feibel, company president, "It is with great pleasure and pride that I review your record of achievement and trace the course of your progress in one of the most difficult fields of engineering and design. Into the sudden, expanding pattern of war, the X-ray is deeply woven and is a vital necessity, both upon the battlefield and in the processing of the Army. For your research and ingenuity in the substitution of wood for aluminum and other critical metals, the Army is deeply grateful."

Wartime output of the company, now operating two plants in Covington goes to the Army and the Navy, besides being used in important industrial uses allied with the war effort.

LINCOLN FOUNDATION ANNOUNCES AWARDS OF ENGINEERING UNDERGRADUATE PROGRAM

Application of arc welding to the design and construction of a jig for use in manufacture of electrical equipment, an arc-welded chair and a radio tower were the respective subjects of papers for which engineering undergraduates of leading universities received the first, second and third awards in the Engineering Undergraduate Award and Scholarship Program of The James F. Lincoln Arc Welding Foundation, the Foundation announced recently.

The paper entitled, "Arc Welding versus Casting in the Design of Jigs and Fixtures," won Herman J. Brenneke of New York University, New York City, the first award of $1000 and the additional honor of having four scholarships of $250 each presented in his name to his university's department of mechanical engineering. Mr. Brenneke's paper,which contained 17 typewritten pages, 3 photos and 6 drawings, showed his own redesign of a jig for welded construction and a description which emphasized the benefits of welding. The description indicated a saving in cost of $45.18, and a saving in time of 17 hours. The author points out that in economy, strength, versatility and weight, welding is much superior to casting.

"An Arc-Welded Chair" was the subject of the paper for which Robert Edson Lee of Iowa State College, Ames, Iowa, received the Foundation's second cash award of $500 and the additional honor of two scholarships of $250 each presented in his name to his university's department of architectural engineering. His paper consisted of 9 typewritten pages, 1 photo and 7 drawings. It described the advantages resulting from arc-welded construction, consisting of durability, economy and rigidity.

Application of arc welding to the design and construction of a radio tower was described in the paper for which Charles L. Sammons and John H. Stewart of The Ohio State University, Columbus, Ohio, jointly received the Foundation's third cash award of $250 and the additional honor of a $250 scholarship presented in their names to their university's department of civil engineering. Consisting of 37 typewritten pages, 3 photos and 11 drawings, the paper explains the benefits gained by redesigning this tower for arc-welded construction, resulting in simplicity of fabrication, and producing a rigidity not obtainable by bolting.

In all, 77 awards, totaling $5000, were made by the Foundation to students representing 33 colleges and universities. The total of the 7 scholarships won by students for their universities was $1750.

The Engineering Undergraduate Award and Scholarship Program was announced December 1st last year and closed April 1st.

Judging of the papers was under the direction of Dr. E. E. Dreese, chairman of the jury of award. Preliminary judging was done by Dr. Dreese assisted by 6 faculty members of Union College, Schenectady, N. Y., where the first step of the judging took place. Final judgment was carried out at Buffalo, N. Y., by Dr. Dreese, assisted by Robert E. Kinkead, widely known welding consulting engineer, Cleveland, Dr. J. C. Hodge, vice-president, Wellman Engineering Co., Cleveland, who is located at the company's Akron plant, and W. C. Landis, works manager of the Westinghouse Air Brake Co., Pittsburgh, Pa.

The Engineering Undergraduate Program is the third award study project sponsored by the Lincoln Foundation. Its object, as set forth in the rules, was "to encourage engineering students to study arc-welded construction so that their imagination, ability and vision may be given opportunity to extend knowledge of this method and thus aid the war effort and economic reconstruction in the peace which is to follow."

As in previous programs, the undergraduate study indicates that while arc welding is being applied extensively, there remain innumerable applications for still further economic utilization of this process.

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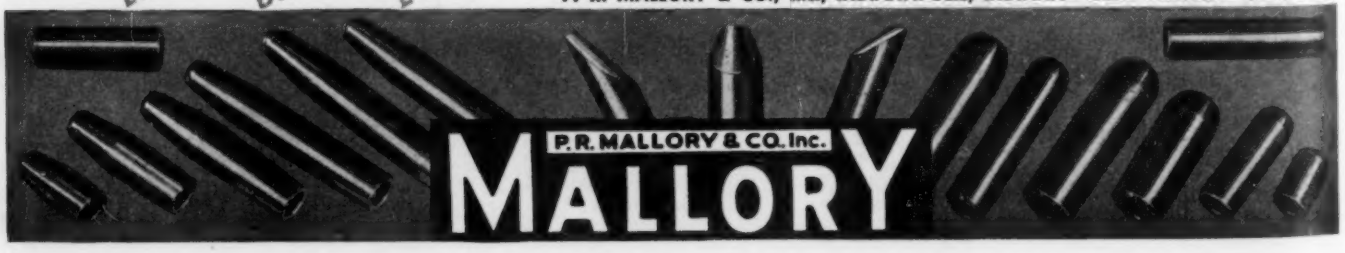
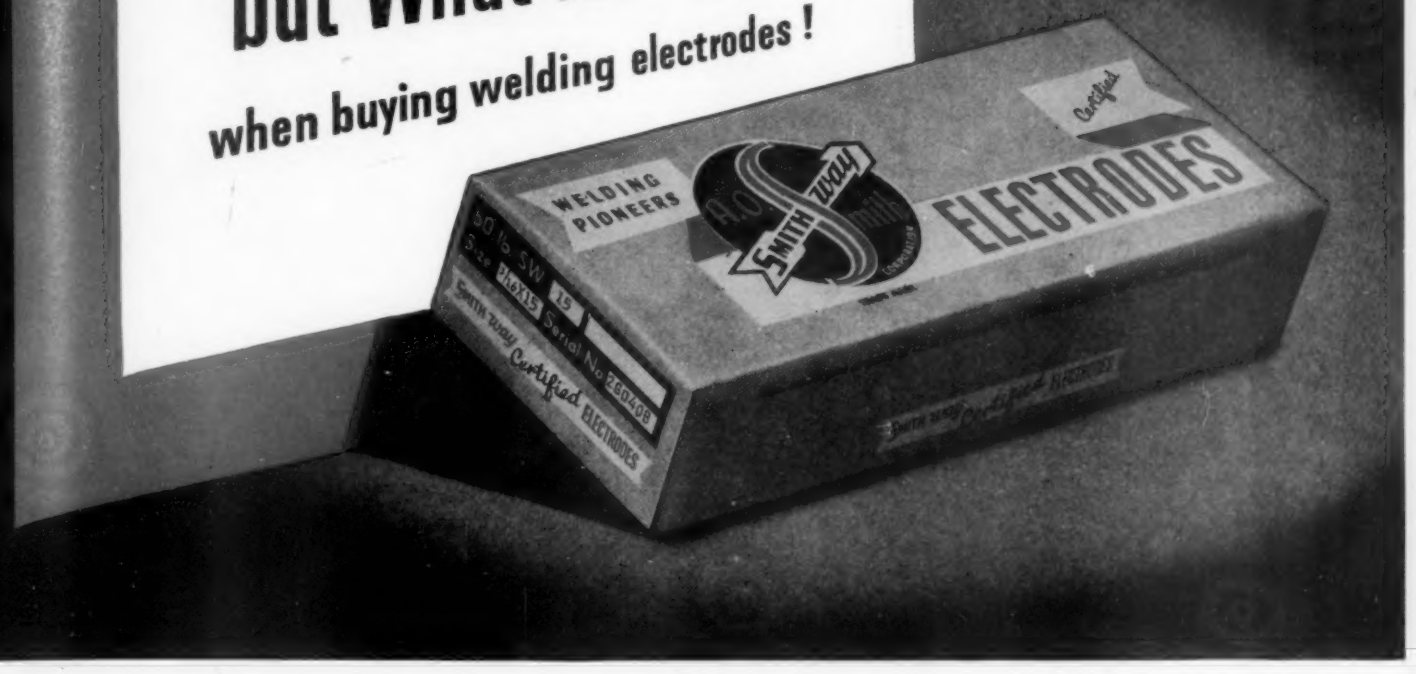


Not What You Pay but What You GET

when buying welding electrodes!



☆ *IF* all welding electrodes of the same type were exactly alike, or even very similar, there would be no question as to which to buy.

But welding electrodes are *not* alike. They are not even "very similar." We know this to be a fact, for we spent several hundred thousand dollars to discover it. Our laboratory and shop tests reveal with definite finality that the price per pound of electrodes does *not* determine the *material* or the *time cost* of welding. Both of those figures are governed by what you *get* from electrodes—not what you pay per pound.

With us, welding electrodes are *production tools*. We manufacture the SMITHway Certified Welding Electrodes used in our plants in order to assure the quality, the uniformity, and the characteristics essential to more *good* welds per man-hour. We offer others who do welding the same electrodes.

If you feel that there is little if any difference in welding electrodes, we think we can *prove* that the price you pay for SMITHway Certified Welding Electrodes *buys* considerably *lower welding cost*—and considerably *better welding results*.

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Made by welders . . . for welders

SMITHway Welding Monitor: *cuts time cost of training welders as much as 33⅓% by automatically signaling operator when correct feeding speed is or is not being maintained.*

SMITHway AC Welding Machine: *no arc blow; reduces spatter losses; effects worthwhile overall power saving; gives more good welds per man-hour.*

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OBITUARY

Thomas A. Wry, who was familiarly known by his hundreds of friends at the Lynn and other plants of the General Electric Company, as "Tom," died of a heart attack on April 19th on the golf links at the Colonial Golf and Country Club in Lynnfield Center. He was 66 years of age.

"Tom" was first employed in 1909 in the Die Dept. of General Electric. He specialized in die design and development for several years and became one of the outstanding men in the company and the entire country on the deep steel die drawing process.

During the first World War, he was on three-inch shell work for the Russian Government making brass casings. He did an outstanding job at that time.

After the war, he returned to the River Works where he concentrated again on die casting development work. For the past several years, "Tom" had been working on special assignments and in the last year he had been engaged in important work of a confidential nature.

He was active in many G.E. organizations and was a member of the Engineering Association, the Thomson Quarter Century Club and the Elfun Society. He was a noted sportsman and an excellent fresh water fisherman.

Some of the old-time members of the AMERICAN WELDING SOCIETY will recall Tom Wry's activities as organizer and first chairman of the Boston Section in 1922 and as promoter and sponsor of the first welding and cutting exhibit held at M.I.T. in Cambridge, Mass.

"Tom" was also largely responsible for the financial success of the 1931 Annual Meeting held in conjunction with the National Metals Exposition. This meeting, incidentally, put the Boston Section on a sound financial footing where it has remained ever since.

In recent years "Tom" was not active in the SOCIETY as he was no longer connected with the welding industry. He maintained his personal friendships, however, with many of the members of the Boston Section and other members of the SOCIETY.

SUSTAINING COMPANY

Ingersoll-Rand Company, 11 Broadway, New York, N. Y., manufactures portable and stationary air and gas compressors; reciprocating vacuum pumps; turboblowers; oil and gas engines; surface barometric and jet condensers; centrifugal pumps; rock drills and accessory equipment; pneumatic riveters, chippers, grinders, diggers, rammers, impact wrenches and hoists. Plants are located at Phillipsburg, N. J.; Painted Post, N. Y.; and Athens, Pa.

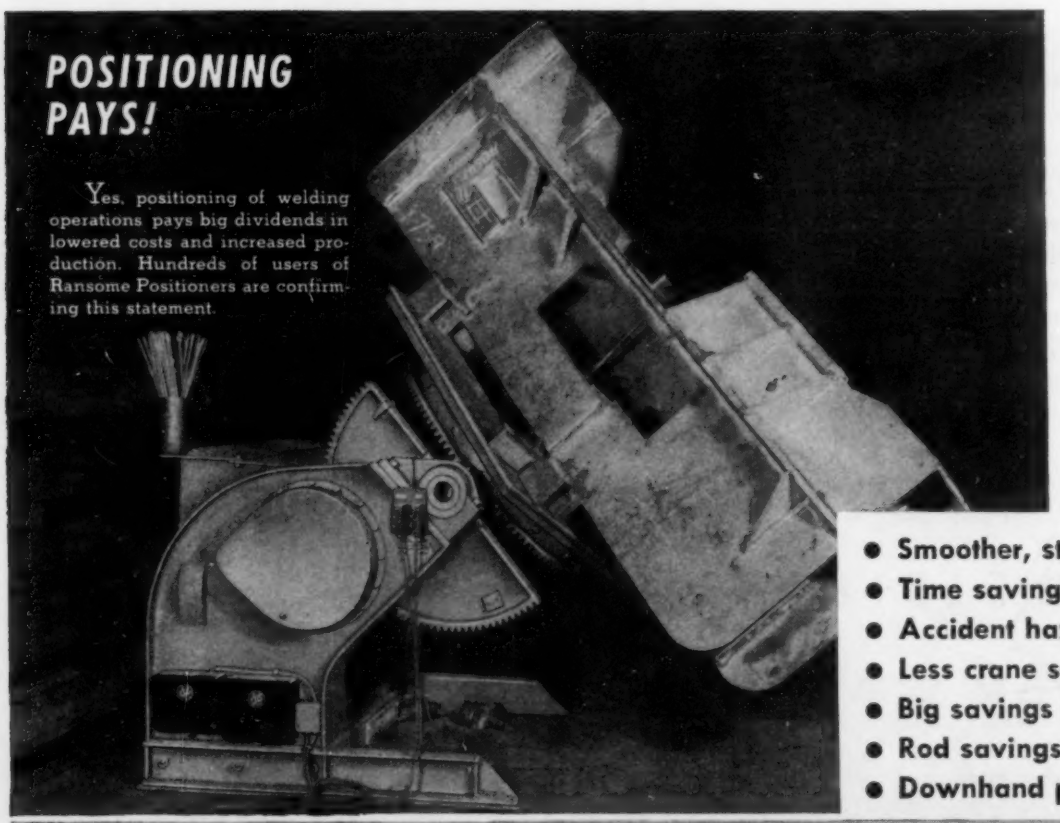
MEETING IRON AND STEEL ENGINEERS

Hiland G. Batcheller, Director of the War Production Board's Steel Division, will address the Association of Iron and Steel Engineers at its annual spring conference at Pittsburgh, Pa., on May 10th.

Mr. Batcheller will discuss some of the problems in the development of the steel expansion program by which, in a comparatively short time, the nation is expanding steel-making capacity by more than 9 million tons. The steel division chief's past experience and present position enable him to bring a message of particular interest to the management and engineering personnel of the steel industry.

Other speakers at the spring conference, which is sponsored by the Association's Rolling Mill Committee, will include Joseph Sparks, of the Swindell-Dressler Corp., Ralph Wright, Westinghouse Electric & Mfg. Co., H. H. Talbot, United Engineering & Foundry Co., Alex Montgomery and J. B. Holbrook, Carnegie-Illinois Steel Corp., and O. A. Bamberger, Republic Steel Corp.

The meeting will be opened by F. E. Flynn, manager of Republic Steel Corp.'s Warren district, and president of the Association, and will be under the general chairmanship of H. G. R. Bennett, Carnegie-Illinois Steel Corp.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- Less crane service required.
- Big savings in floor space.
- Rod savings up to 7%.
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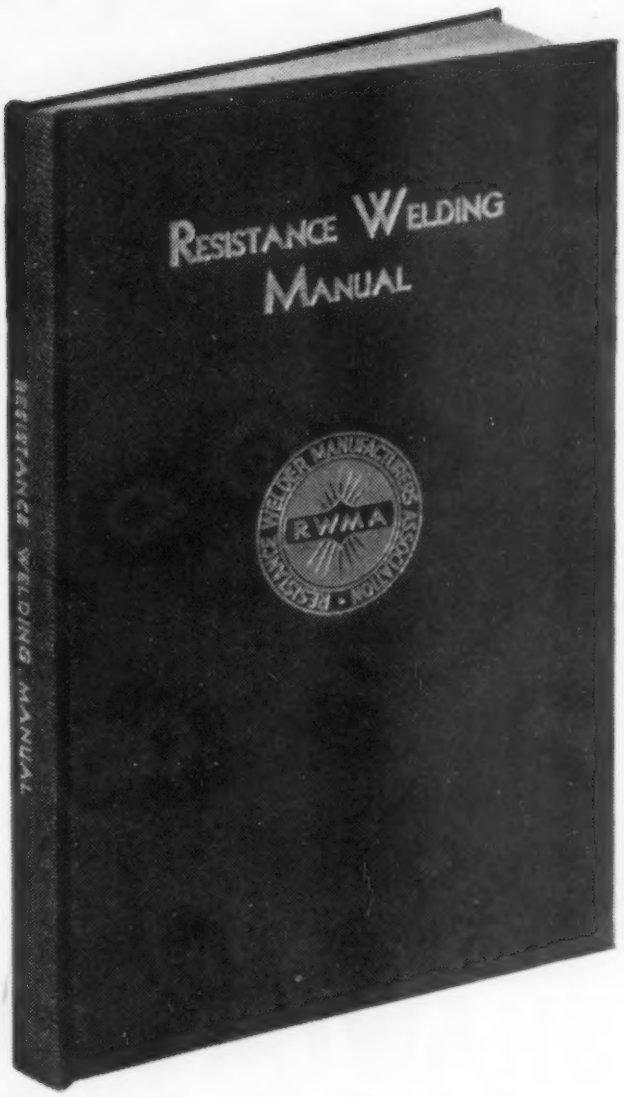
JUST PUBLISHED

The first and only

authoritative reference book

covering all phases of resistance welding exclusively.



6 Chapters
286 pages
205 tables, charts and illustrations

The RESISTANCE WELDING MANUAL was written and prepared by a group of resistance welding experts under the joint sponsorship of the Resistance Welder Manufacturers' Association and the American Welding Society.

All of the material in the book was originally included in the second *(1942)* edition of THE WELDING HANDBOOK published by the American Welding Society.

Realizing the urgent demand for resistance welding information and data, the Resistance Welder Manufacturers' Association, by arrangement with the American Welding Society, has now separately published all of the HANDBOOK material dealing with resistance welding. By this arrangement, it is now possible to obtain all of the resistance welding material without the necessity of securing the entire WELDING HANDBOOK.

This material has not been condensed or abridged in any manner.

Price $2.50 postpaid

THE RESISTANCE WELDER MANUFACTURERS' ASSOCIATION

505 ARCH STREET PHILADELPHIA, PENNSYLVANIA

EDUCATIONAL FILM HELPS TRAIN MEN

When Permanente Metals Corp., the Henry J. Kaiser organization that operates those record-breaking shipyards on the West Coast, decided to standardize on an improved technique of vertical welding instruction, a motion picture was ordered for use in the welding school.

Script preparation and production of the picture were assigned to Photo and Sound, San Francisco, producer of motion pictures and slidefilms.

The completed picture, "Short Whip Vertical Welding," is a one-reel sound film in natural color, teaching an efficient, approved method of vertical arc welding that is quick and easy for the welder-trainee to learn. Although the picture was produced in collaboration with Permanente Metals, prints are available for purchase by schools and industrial firms desiring to teach this new vertical welding technique.

When the producer was assigned the job of photographing an electric arc, a neat problem in light control and exposure speed was posed. Ordinary means of photography would not do because of the intense light produced by the arc. A series of tests provided the answer . . . during the scenes in which the arc itself was being shot, sufficient light was poured on the background to match the intense light from the arc and the exposure speed was adjusted accordingly. The result of this careful balance was to cut down arc flare and show on film just what takes place within the arc as a weld is made.

With the aid of this film the welder-trainee is able to see through the arc and study what is happening to the molten metal reacting to the tremendous heat. The exact color of the arc is reproduced, as is the color of the molten pool. The freezing of the molten metal and formation of the bead are clearly shown and the sound of the arc is realistically reproduced.

Explanatory narration accompanies each scene so that the basic points of the short whip technique are clearly demonstrated.

In order to obtain sufficient lighting to enable the cameramen to record the close-ups of the arc, four searchlight-type arc spotlights with concave mirrors and one two-arc floodlight were used to concentrate tremendous candlepower on an area about 6 in. square. The result of this concentration of intense lighting was, of course, to produce terrific heat, so much, in fact, that the wax pencils used to mark the scene slate were melted and the slate frame itself scorched.

"Short Whip Vertical Welding" is exceptional for training either as an independent production or in conjunction with welding training films already available. It deals with machine setting, angle of electrode, control of arc gap and speed of travel. It demonstrates the purpose of the short whip technique and shows its application to both fillet and groove welds. Slow motion scenes are employed to allow careful study of exactly how the short whip method works.

Motion Pictures of Actual Welding Demonstrate Proper Angle of Electrode in Making a Vertical Weld, Correct Arc Gap and the Right Speed of Travel.

ANNUAL MEETING

Chicago Oct. 18–21

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You will find EFFECTIVE, SAFE Oakite cleaning makes possible MORE UNIFORM, stronger welds . . . helps increase output. Special technical bulletin giving details FREE to process engineers, welding supervisors, foremen and other executives responsible for this work.

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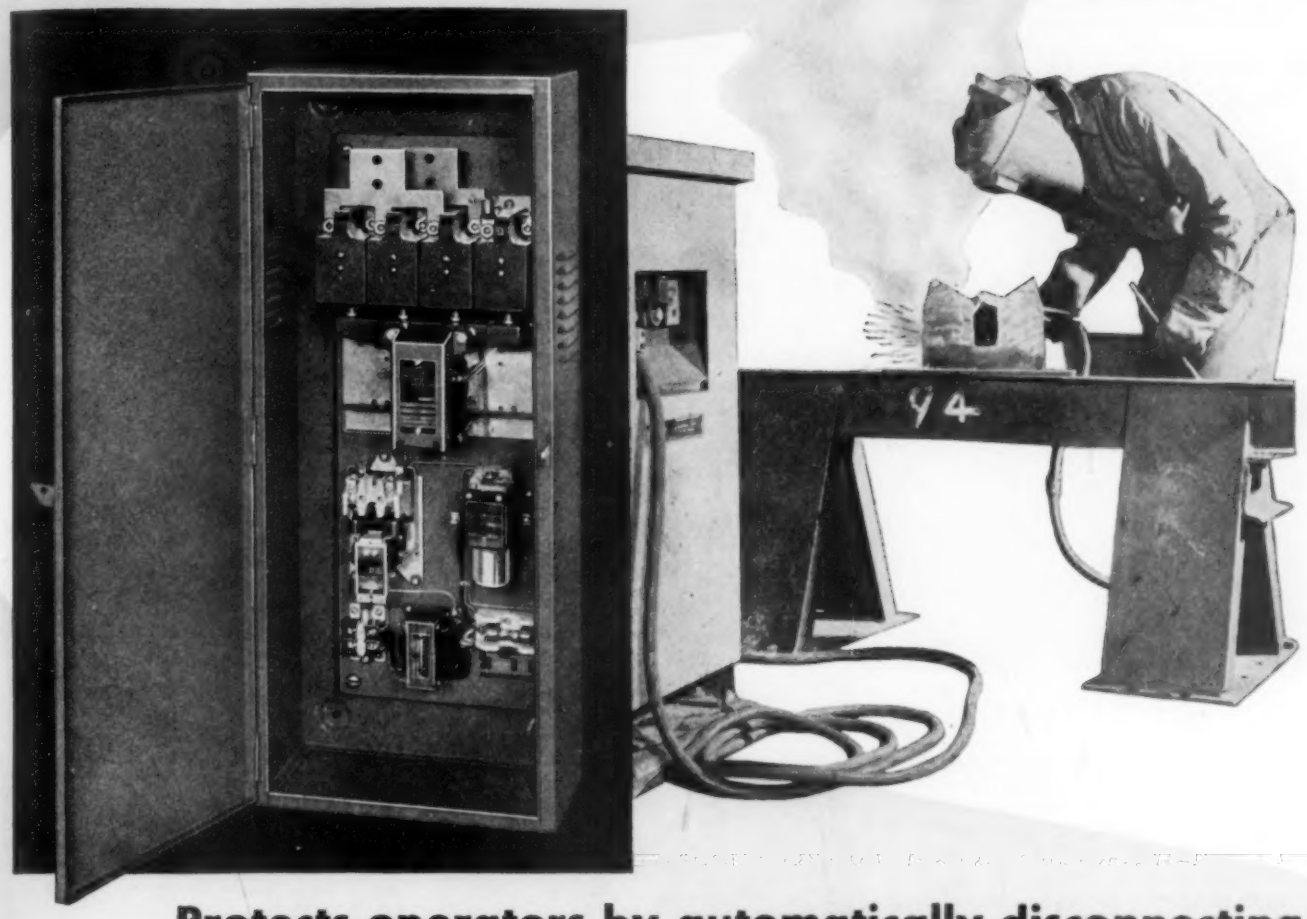
SAFETY CONTROL FOR A·C· ARC WELDERS



Protects operators by automatically disconnecting welding transformer when arc is broken . . . .

HIGH open circuit voltages of A. C. arc welders (transformer type) create a definite hazard to operators. Physical contact from electrode to grounded metal surfaces (when not welding) is sometimes serious.

Square D's new class 8992 safety panels eliminate this hazard by automatically disconnecting the welder transformer after the arc is broken. The transformer is automatically reconnected the instant the operator touches the electrode to the work. Thus, the arc is struck with no delay. There is no loss in operating speed or efficiency.

There is an economy angle, too. When Square D safety panels are used, the welding transformer primary circuit is connected to the power line only while the arc is held. Substantial saving in power is effected when a number of welders are used on a single power system and the power factor is improved.

These new safety panels can be used with any make or model of A. C. transformer type arc welder. External connections are simple and internal connections of the welder need not be disturbed.

ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

J. C. TRAVIS ELECTED HANDY & HARMAN DIRECTOR

At a meeting today of the stockholders of Handy & Harman, Judson C. Travis of Morristown, N. J., assistant to the company's president, was elected a director of the company.

The new post comes to Mr. Travis as he completes his 25th year of company service. Starting during the last war as an office boy in 1918, he soon displayed qualities that led to his promotion to more responsible positions.

J. C. Travis

He has headed up sales and advertising activities of Handy & Harman for many years and five years ago became assistant to Mr. G. H. Niemeyer, the company's president. In that capacity his principal efforts since the beginning of the war have been directed to the development of the company's rapidly expanded war activities.

Mr. Travis takes the place, on the Handy & Harman Board of Directors, of Mr. H. H. DeLoss recently deceased.

ARC WELDING NEWS

Hobart Bros., Hobart Square, Troy, O., offers to send copies of their Arc Welding News free to any of our readers interested in having their name put on the mailing list.

COPPER AND COPPER BRASS ALLOYS

Copper and Copper Base Alloys, by R. A. Wilkins and E. S. Bunn. Published by McGraw-Hill Book Co., Inc., New York and London. Price $5.00. 355 pages, $8^1/_2$ x $11^1/_2$ in. The physical and mechanical properties of copper and its commercial alloys in wrought form are discussed. The data presented here have been compiled for the purpose of rendering readily available reasonably complete engineering data on each of those many alloys of copper that are of commercial significance.

DOW PRODUCING MAGNESIUM IN NEW PLANT HAVING BUS BARS OF SOLID SILVER

Electric current flowing through huge bus bars of solid silver brought another great magnesium plant into production recently, as Dow Magnesium Corp. poured its first metal in the fifth Dow-process plant built by The Austin Co. for the Defense Plant Corp., to meet the wartime demand for this lightest of all structural metals.

Washington officials representing the Defense Plant Corp. and the War Production Board looked on as the metal derived from salt brine flowed from the first of hundreds of electrolytic furnaces soon to be in service at this plant. In full production, it will equal the largest of its kind.

The silver almost completely replaces copper in the power distribution lines required for large-scale production of magnesium, and was loaned to DPC by the Government for this use to release copper for shells, ordnance equipment and other war needs in which no substitute will do. The silver is even more efficient as a conductor of electricity but would not normally be used because of its excessive cost.

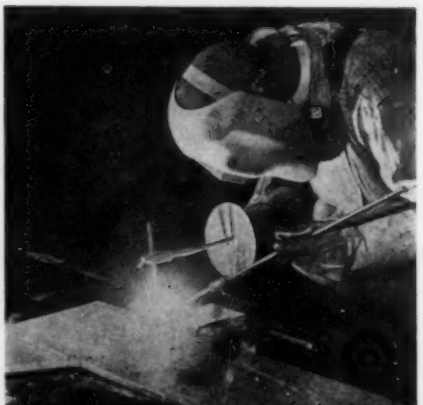


Fig. 1—This Austin Company Welder Is Working on a Section of Solid Silver Bus Bar in the Fabricating Shop at the Dow Magnesium Corp.'s New Michigan Plant, Which Recently Produced Its First Magnesium Metal. The Government Loaned This Silver to the Defense Plant Corp., Which Owns the Plant, in Order to Relieve the Demand for Copper Needed for Cartridge Casings and Many Types of Ordnance Equipment for Which It Is Essential

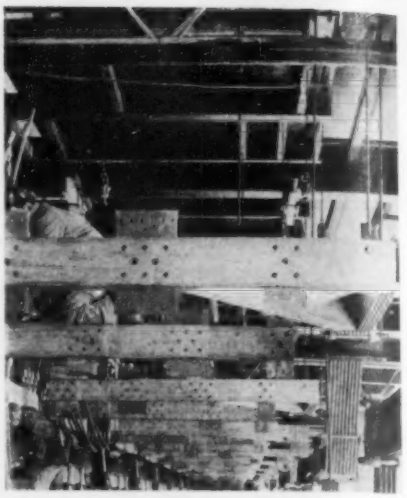


Fig. 2—Solid Silver Has Been Used Throughout the Bus Bars Which Carry Power Through the Magnesium Cells at Dow Magnesium Corp.'s New Michigan Plant. This Photograph, Taken During Construction, Shows How the Silver Bus Forms a Virtual Canopy Over the Cells

SUSTAINING MEMBER

Southeastern Shipbuilding Corporation, Savannah, Ga., started the production of Liberty ships in May of 1942. Although construction of facilities is still incomplete, they have launched thirteen hulls from their six shipways, built on land reclaimed from the marshes for this purpose. Eleven of these all-welded ships have been delivered to the United States Maritime Commission and deliveries are continuing at the rate of at least three ships per month. More than 2000 welders are employed, over 60 % of them having been developed in the yard's 60 booth welding school.

Annual Meeting

HOTEL MORRISON

Chicago Oct. 18–21

Make Reservations Early

ELECTROLOY ALLOYS for RESISTANCE WELDING ELECTRODES and DIES

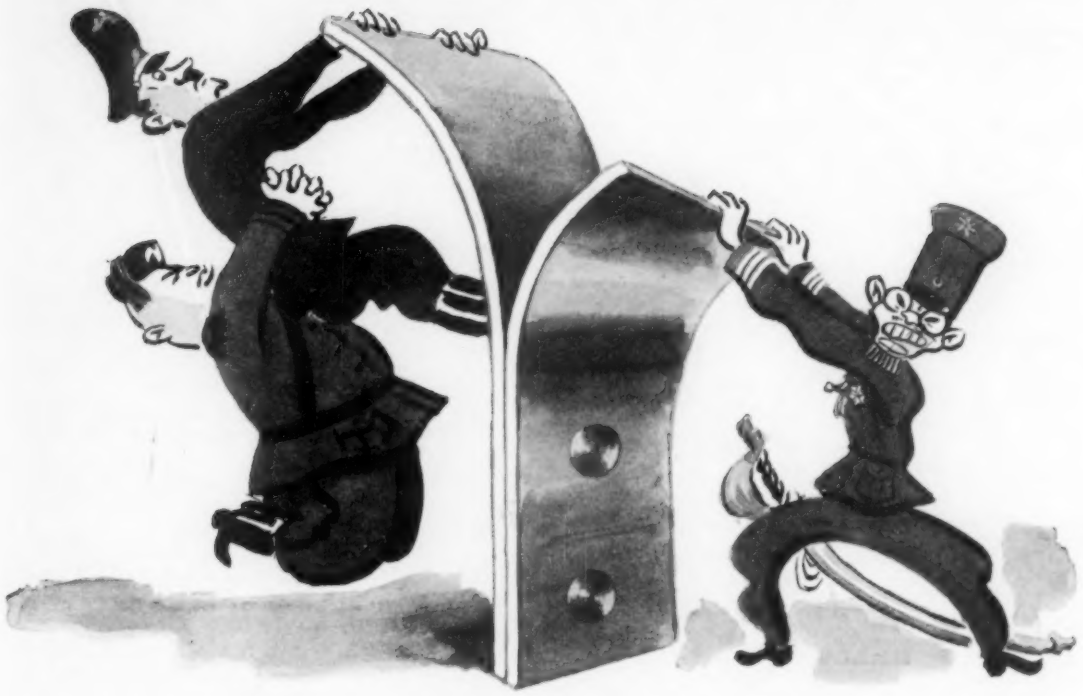
Spot
Seam
Butt
Flash
Projection

ELECTROLOY ALLOYS were developed specifically for the resistance welding industry. ELECTROLOY ALLOYS cover the full range of physical properties necessary to the manufacturers and users of resistance welding equipment.

Our engineers will be glad to make recommendations for your special electrodes. Submit samples or specifications.

Catalog and prices available on request.

THE ELECTROLOY COMPANY, Inc. 1600 Seaview Avenue, BRIDGEPORT, Connecticut

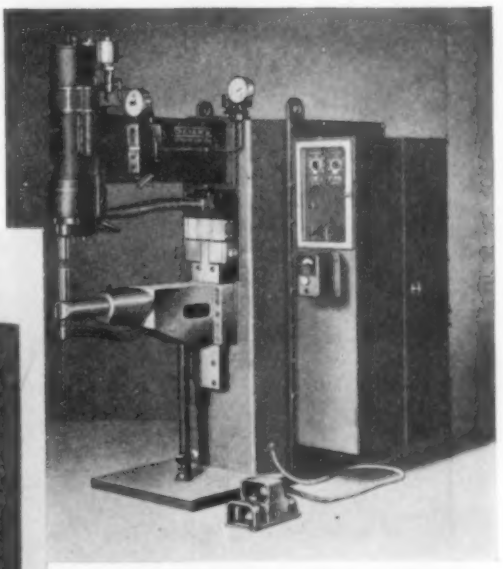


THE AXIS CAN'T TEAR US APART!

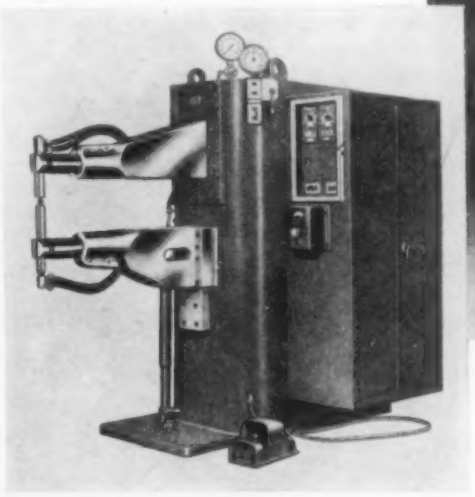
The Sciaky Process is helping fabricate our mighty flow of war materials with STRONG, SOUND, UNIFORM WELDS!.

Adolph, Hirohito and Benito are beginning to feel the sting of our growing air power. However, America's program of 100,000 military aircraft in 1943 calls for faster production methods, stronger structures and fewer rejects.

The Sciaky Process of Electric Resistance Welding is helping to meet these needs with a superior method of spot welding aluminum and its alloys. Utilizing STORED ENERGY, VARIABLE PRESSURE and PRE-HEATING, these exclusive Sciaky features make possible the fabrication of sturdy, primary and secondary stressed assemblies at high speed.



TYPE PMCO. 2516 SCIAKY ELECTRIC RESISTANCE WELDER. Eighty spot welds per minute on two sheets of light alloy of .040" each. Welding capacity — from two thicknesses of .016" each in light alloys up to .091".



SCIAKY TYPE PMCR. 2516 ELECTRIC RESISTANCE ROCKER ARM WELDER, welding 70 spots per minute, on two sheets of aluminum alloy of .040" each. Welding capacity from two thicknesses of .016" in aluminum alloys up to and including .080".

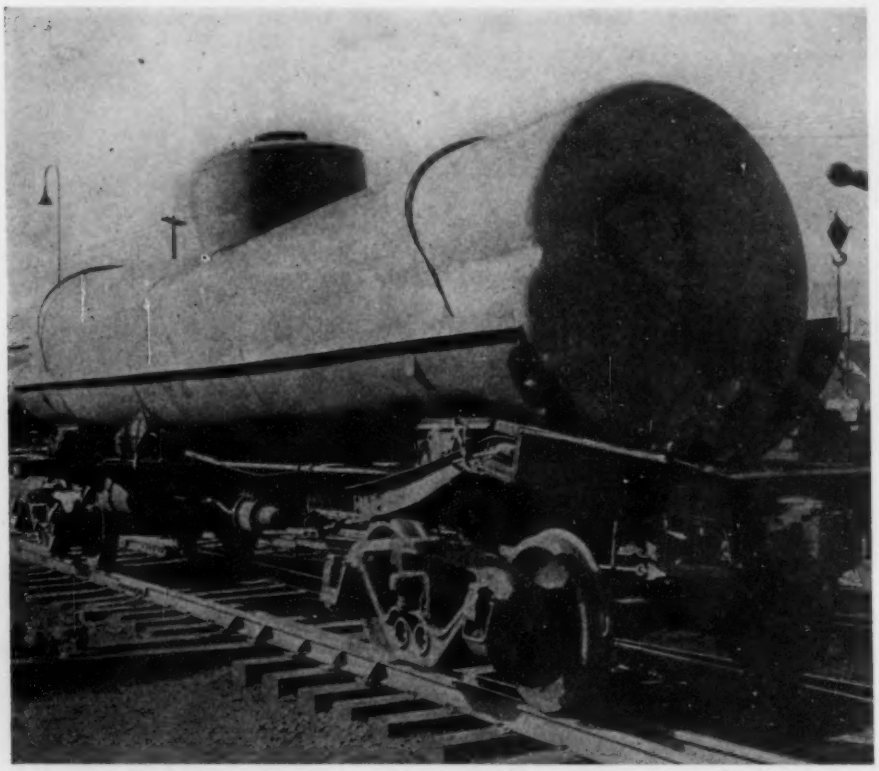
SCIAKY BROS.

Manufacturers of a Complete Line of
A.C. and D.C. Electric Resistance Welding Machines.

4915 WEST 67th STREET • CHICAGO, ILLINOIS

TANK CAR ACCIDENT

The accompanying illustration shows an 8000-gallon class ICC-103W, single compartment welded tank car severely crushed in railroad collision which sent cars hurtling down embankment. The car rolled over completely, the dome caved in the tank top sheets and both main heads were badly deformed. Retesting of the tank before any repairs were made revealed not the slightest sweat leak in the welded seams. The tank was fusion welded by the Unionmelt process. Photograph taken after retesting gives some idea of damage to the tank although the retesting straightened it out somewhat according to American Car and Foundry Company, builders. The tank was stress relieved.



OFFICE OF WAR INFORMATION

"Handbook of Emergency War Agencies," prepared by the Office of War Information, is a guide to Federal agencies all of whose present functions are devoted to the war activities. It does not include the activities of the agencies established for other purposes, even though much of their work today has been integrated with war program. The handbook is designed to help the public reach the services it needs within the emergency war agencies.

Copies of the handbook may be obtained by writing to Superintendent of Documents, Government Printing Office, Washington, D.C. Price 20 cents each.

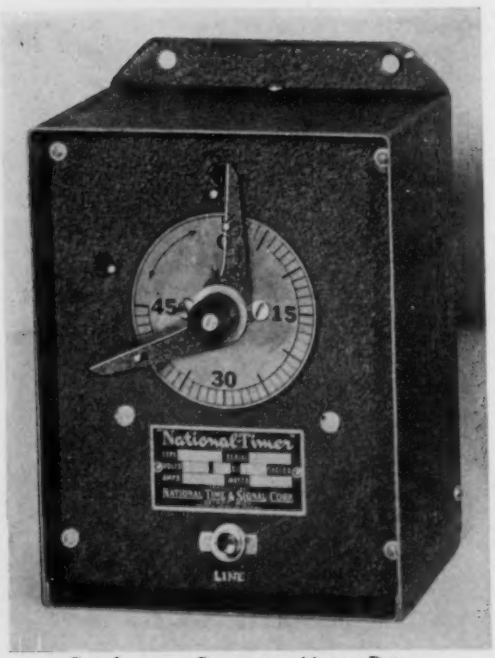
WELDING HANDBOOK

1942 Edition 1600 pages

$5.00 to Members

$6.00 to Non-Members

NATIONAL CLUTCHLESS INTERVAL TIMERS



Synchronous Reversing Motor Driven. Cabinet Size 6" x 8" x 4½" Deep.

PLAY IMPORTANT ROLES IN WAR WORK.
TIME YOUR PLATING — HEAT TREATING
ALCLAD CLEANING — CORE SAND MIXING

and Numerous other Industrial Processes

Three Standard Time Cycle Ranges

Type 3145S Timer — 0 to 45 Seconds
Type 3104 Timer — 3 Seconds to 4½ Minutes
Type 3145 Timer — 20 Seconds to 45 Minutes

STANDARD CONTROL ARRANGEMENTS

1. Non-repeat Control. Operator starts Timer, Load goes 'On'. At end of pre-set Interval, Load 'Off'. Timer stops.
2. Same as #1, except a warning signal, (either light or bell) is initiated by Timer at end of operation.
3. Delayed Action. Operator starts Timer. After pre-set Interval, Load goes 'On' and Timer Stops.
4. Double Circuit Non-repeat. Operator starts Timer. #1 Load goes 'On' and times out. #2 Load then goes 'On' for same Interval, then 'Off', following which, Timer stops.
5. Repeat 'On' and 'Off'. Timing Interval for each period the same.
6. Repeat Operation to control 2 Load Circuit, alternately. #6 is a 3 Wire Load Circuit with common feed. #6a has no common feed.
7. Simple Repeat Control, without Load Circuit, to ring a bell, or light a light momentarily, at the end of each pre-set time Interval.
8. Sequence Type, with variable pre-set timed Intervals, to perform several operations in timed sequence, and stop.

NATIONAL TIME & SIGNAL CORPORATION

600 E. MILWAUKEE AVENUE DETROIT, MICHIGAN

KELEKET
X-RAY
ARMY
E
NAVY
THERE'S a new flag flying over our plant—our distinguished service medal—the Army-Navy "E" Award for excellence in war production.
Quietly, traditionally, KELEKET performs the job assigned — and in the performance makes a "major contribution to victory."
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212 West Fourth St. . . . . Covington, Ky.
PIONEER CREATORS OF Quality X-RAY EQUIPMENT SINCE 1900

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

NEW A.-C. WELDER LINE

With a view to expanding its welding equipment service to war industries, Harnischfeger Corporation, Milwaukee, Wis., announces the addition of a complete line of Industrial a.-c. arc welders to its present extensive line of P&H d.-c. machines. Engineered and built for industrial service, these machines are being made in 7 Heavy Duty and 4 Intermittent Duty models with a range of capacities for handling production welding under continuous operation. The new line features the recently adopted "WSR" (Welding Service Range) ratings which show the

actual minimum to maximum output of usable welding current. Specific "WSR" ratings of Heavy Duty models are: 50 to 270 amp., 60 to 375, 90 to 500, 100 to 625, 125 to 750, 150 to 900 and 200 to 1200—of Intermittent Duty models: 20 to 185 amp., 20 to 235, 20 to 285 and 20 to 335. Setting and control of current throughout complete welding service range involves one simple, easy-to-operate adjustment. Improvements in the P&H control over other designs make it creep-proof. According to P&H engineers, the a.-c. models are marked by a number of other mechanical and electrical refinements which, by actual field tests, have shown an increase in operating efficiency up to as high as 95% with appreciably reduced maintenance cost.

ALUBRO WELDING GLASS

An improved welding glass blue in color that allows better vision than the usual green glass for aluminum and bronze welding, glass working, etc., where sodium yellow glare is present, is announced by Willson Products, Inc., Reading, Pa. This glass was developed for reducing sodium yellow glare only. Standard green Willson-Weld glass is still recommended for acetylene and electric arc welding.

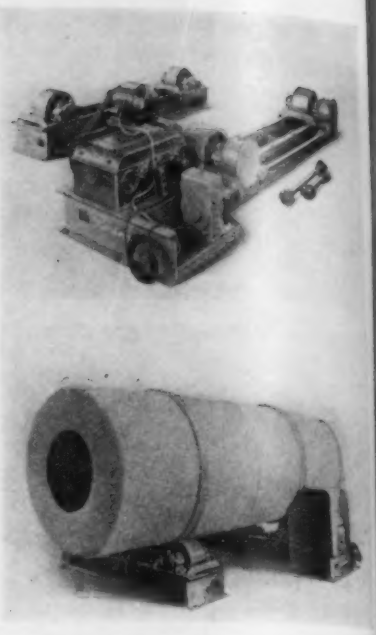
WAR-TIME SOLDERS

Out of the war comes the problem of soldering with low tin-content solders. But industry has quickly found the solution in a new flux known as Lloyd's No. 6 Soldering Fluid, manufactured by Lloyd S. Johnson Company, 2241 Indiana Ave., Chicago, Ill. Here is a flux that breaks down lead-rich solders into a fluid that will flow into inaccessible places. It has high enough capillary action to make solder flow evenly and completely through solder joints and provides even higher tensile strength than heretofore obtained with 50–50 solders. Users report that now they can get finest results from $2^1/_2$ to 6% silver-lead solders, as well as any of the low-temperature solders. It is ideal for soldering zinc-coated sheet metal (both galvanized and electroplated), lead-coated sheet metal, tin plate, Terne-plated, brass, copper, steel and all types of sweat fittings. Also makes lead burning jobs easy. Material does not crawl or creep, has no irritating or choking fumes. It is so highly concentrated that you can dilute it with one to two parts of water for materials that are easy to solder. A free sample of Lloyd's No. 6 Soldering Fluid will be mailed to any company making direct request.

RANSOME OFFERS TURNING ROLLS FOR WELDING LARGE CYLINDRICAL WORK

For position-welding long drums, tanks and other heavy cylindrical pieces, the Industrial Div. of the Ransome Machinery Co., Dunellen, N. J., offers the turning roll set illustrated.

The set consists of a pair of motor-driven rolls controlled through a Reeves variable-speed unit, giving a range of speeds to meet individual job requirements. Remote push button control for forward or reverse rotation is furnished. Means for changing the center-to-center distance of the rollers, for handling work from 2 ft. to 14 feet in diameter, is provided. One or more sets of idler rolls are used, according to the length of the cylinder being welded.



Units of various capacities are available for handling loads up to 75 tons. For further information, address the company.

ALLOY-SPRAYER COATS, "REGALVANIZES", PATCHES

A new, low-cost, rapid means of applying a protective metal coating to metal assemblies or structures, of recoating areas burned by welding, of patching or repairing small areas in large galvanized assemblies where the coating has been damaged and in addition providing an ideal base for painting, is announced by Alloy-Sprayer Company, 2040 Book Bldg., Detroit, Mich.

An actual tinning of the sprayed metal with the base metal has been effected by this process. Thus, under certain conditions, sandblasting or other extensive preparation of the surface of the base metal is not necessary.

TREATMENT OF BURNS

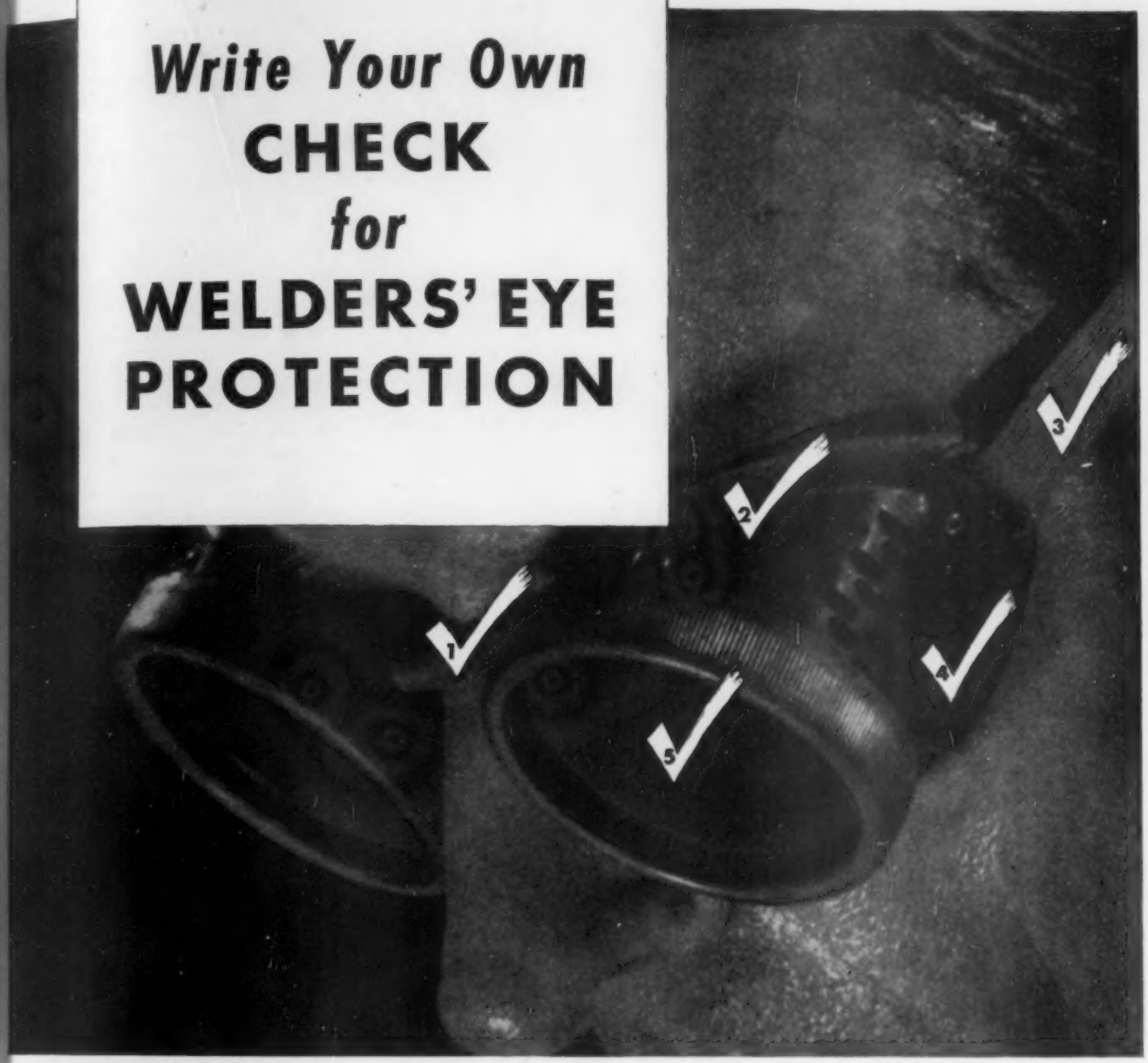
The manufacturer Lee-Wood, Inc., South Norwalk, Conn., claims that cōlēn solution is unusually beneficial in treatment of burns in that it relieves pain, cleans the wound and avoids infection.

ELECTRONIC BRAZING SERVICE OF CARBOLOY

Commercial availability of electronic induction equipment for routine brazing of carbide tools using any suitable brazing medium including copper is announced by Carboloy Company, Inc., Detroit, Mich.

While based on standardized units, their use in each case is to be engineered to the needs of individual organizations—recommendations as to size of unit or units, basic

Write Your Own CHECK *for* WELDERS' EYE PROTECTION



Check the check-marks—to understand better why the AO 404 Duraweld Goggle provides so much *safety* and *comfort.*

✓ The rubber-insulated ball-chain bridge is unusually comfortable and allows quick, easy, permanent adjustment.

✓ The individual eye-cups are made of light durable composition and shaped to fit the orbit of the eye. The perfect fit prevents entrance of sparks or stray light. Round edges provide comfort.

✓ The headband is easily adjustable, will not pull the hair, helps give all-day working comfort.

✓ To help keep the lenses from fogging, ample ventilation is provided by indirect louvres which protect against flashes and splashes of metal.

Non-reflecting, composition lens rings hold lenses securely.

✓ To protect welder's eyes from injurious ultraviolet and infra-red rays, you have four lenses to choose from—Calobar, Noviweld, Filterweld and Noviweld-Didymium—in a wide range of shades and densities.

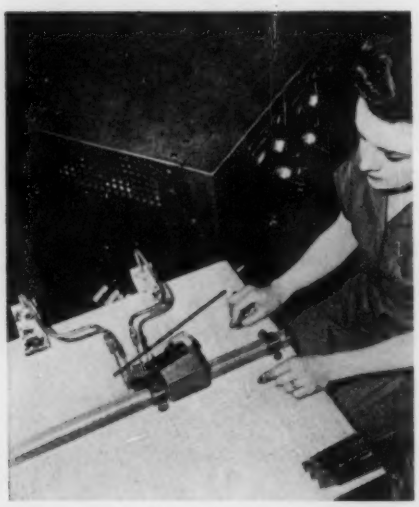
There is an AO Branch office in every industrial center. The Safety Representatives in the Branch near you will be glad to tell you all about AO scientific, dependable eye protection for welders.

American Optical
COMPANY
SOUTHBRIDGE, MASSACHUSETTS

coil designs, etc., being supplied by the Carboloy engineering department on the basis of the individual user's needs.

Among the numerous advantages of induction brazing of carbide tools over other methods are:

1. Greater convenience—brazing technique is much simpler than when either furnace or torch brazing is used.
2. Greater speed. Heating is confined to the actual area desired. Time required to braze a tool is cut from minutes to seconds.
3. Greater simplicity. Unskilled labor can be used to braze carbide tools with induction equipment.

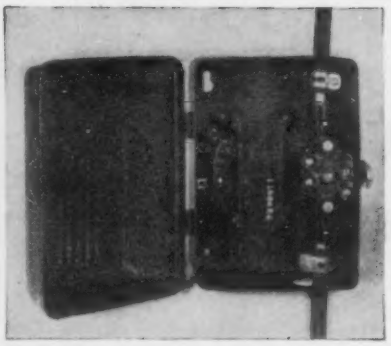


4. Accurate and automatic control. The amount of heat and its distribution can be controlled in electronic induction brazing as by no other method. Prevents incomplete brazes or cracking of tips due to localized overheating.
5. Lower operating cost. One hundred average tools can be brazed for less than 10 cents total power cost. There are no furnaces to preheat.
6. Less brazing material needed. Less flux, etc., is required in induction brazing than in other methods.

NEW ELECTRO-THERMOSTATIC FLOW SWITCH ANNOUNCED

For resistance welding and other applications, a new electro-thermostatic flow switch which detects the lack of proper cooling water required for adequate cooling of ignitron tubes is announced by Westinghouse Electric & Mfg. Co.

The electro-thermostatic flow switch is designed for use where a liquid is used for cooling and where a smooth positive acting flow switch is required. It consists of a 100-watt transformer having a one-turn secondary short circuited through a piece of high-resistance stainless steel tubing through which flows the water from the ignitron tubes. A normally closed two-pole thermostatic switch is



New Electro-Thermostatic Flow Switch Mounted in Cabinet

used. It is available in either a $1^1/_2$ gal. or $3^1/_2$ gal. per minute size in both a 25- or 50/60-cycle 220/440-volt rating. Other voltage ratings are available by supplying an autotransformer.

Furnished with a spring mounting to insure against excessive tightening of the switch elements, the electro-thermostatic flow switch is available with or without enclosing steel cabinet, and all parts are easily accessible for replacements. Mounting space required is approximately 7 in. wide x 9 in. high x 5 in. deep.

Further information may be secured from department 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., or from the nearest Westinghouse office.

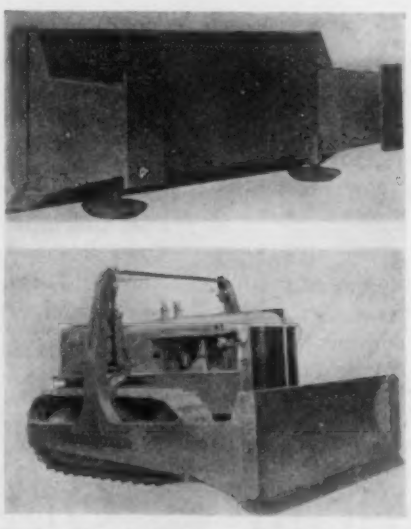
WELDING BULLDOZERS

A demonstration of the savings effected by switching to larger size electrodes was noted recently in the fabrication of bulldozer frames by The Baker Manufacturing Company, Springfield, Ill., in a report to The Lincoln Electric Company.

By increasing electrode size from $^3/_{16}$ to $^1/_4$ in., this concern reduced welding time from $9^1/_2$ to 7 hr., a saving of $2^1/_2$ hr. per unit, or 26%. Thus, one welder alone can increase welding output by approximately two complete bulldozer assemblies per week.

The change to larger size electrodes also effected a saving in labor costs of $1.64 per unit, or over 22%, due to factors such as boosting deposit from 1.32 lb. per hour with $^3/_{16}$-in. size to 2.5 lb. per hour with $^1/_4$-in. size.

As an example of savings made by increasing electrode size, note that by using $^1/_4$-in. size electrode instead of a $^3/_{16}$-in. size, cost per pound deposited is reduced 42%.



Rear View of Bulldozer (Top) with Portion of Beads Visible. Substantial Savings Resulted in Changing from $^3/_{16}$ to $^1/_4$ In. (Below) Front View of All-Welded Bulldozer Installed on Power Tractor

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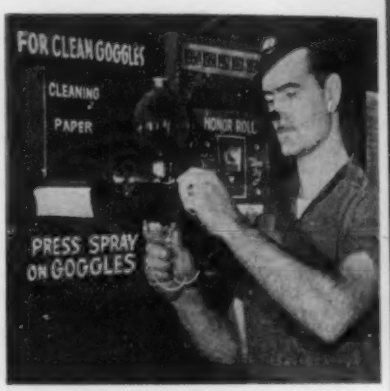
SERVICE STATION FOR DIRTY GOGGLES

An arc welder at the Westinghouse Sharon Works steps up to one of the conveniently located soap and paper dispensers to clean his goggles. A drop or two of the cleaning solution and a piece of paper quickly do the job. It was apparent that without such facilities placed in strategic locations, workers were apt to wear goggles longer between cleaning than they should, with the result of a pronounced drop in vision efficiency.



Cleaning stations consist simply of standard type dispensers for the solution and paper mounted on a board, that is readily located by identifying signs.

REFRIGERATED WELDING ELECTRODE PAPER AT ASRE NATIONAL CONVENTION

The extent to which obstacles to successful resistance welding of aircraft have been overcome by the application of refrigerated welding will be discussed in a paper to be presented by A. L. Munson, Frostrode Products, Detroit, before the national convention of the American Society of Refrigeration Engineers in Cleveland, June 2nd.

Mr. Munson will also trace recent steps in the evolution of the refrigerated welding process with its specialized refrigeration units, etc. Particular emphasis will be placed on experiences with the recently developed "Frostpoint" electrodes designed specifically for use in connection with refrigerated welding.

THIS KNOB OPENED THE DOOR TO *Better Welding*

U·S·S Rolled Steels for Welding include:

U·S·S High Tensile Steels to resist corrosion and increase strength without adding weight.

U·S·S Copper Steels to give twice the atmospheric corrosion resistance of regular steel at little additional cost.

U·S·S Abrasion-Resisting Steel to combat wear and friction.

U·S·S Stainless and Heat-Resisting Steels to assure high resistance to corrosion and heat, and to reduce weight.

U·S·S Carilloy Alloy Steels— Special steels for the special jobs of industry.

U·S·S Hot-Rolled and Cold-Rolled Steels to provide the basic advantages of steel, plus maximum economy in accordance with the requirements of each job.

WHAT does a "door knob" have to do with welding? . . . This particular knob happens to be a welding test specimen, one of many used by U·S·S research engineers to determine the ability of certain welded steels to remain water-tight under severe distortion.

It wasn't even a knob to start with —just two discs of 16-gage steel and an ordinary pipe coupling. First, our engineers welded the coupling into a hole in the top disc, and welded the two discs together around their periphery. Then came the test. Hydraulic pressure at 2100 pounds per square inch was forced through the coupling and between the steel discs, expanding them into the bulging knob you see above. But the weld stayed tight!

This is just one of hundreds of practical tests conducted in United States Steel shops and laboratories to determine the welding characteristics of all types of steel. The resulting fund of welding knowledge is an important "plus" you get when you use U·S·S Rolled Steel for fabricated products. You can apply each steel with a definite understanding of its weldability.

Whatever problems you may be facing in your welding shop, let our engineers help you find the answers. Our welding experience is available to you without obligation. Just write to us about your problem. We will do our best to give you a helpful answer.

U·S·S ROLLED STEELS FOR WELDING

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

List of New Members

April 1 to April 30, 1943

BIRMINGHAM

Donoho, C. K. (C), American Cast Iron Pipe Co., Birmingham, Ala.

BOSTON

Barker, Harold L. (B), Barker Steel Co., 42 School St., Watertown, Mass.
Benedetti, Dandalo B. (D), 77 Greenlawn Ave., Haverhill, Mass.
Boutin, Joseph R. (D), 261 Hillside Ave., Arlington, Mass.
Bramley, Jack W. (D), Main St., Boylston, Mass.
Casey, Thomas F. (D), 17 Chase Ave., Lexington, Mass.
Cowin, John J. (C), R.F.D. 4, Portland, Me.
De Rosa, Thomas (D), 44 Magnolia St., Dorchester, Mass.
Gosselin, Harold J. (D), 47 E. Springfield St., Boston, Mass.
Guthrie, Stephen J. (D), 10 Malvern Terrace, Medford, Mass.
Johnson, Peter J., Jr. (D), 17 Stanton St., Malden, Mass.
King, Omar R. (C), 29 Sylvan Rd., S. Portland, Me.
Langshaw, Arnold D. (B), 37 Lowden Ave., Somerville, Mass.
Lucier, Edward W. (D), 16 Oltamont St., Haverhill, Mass.
McGuire, Frank J. (D), 117 Greenfield Rd., Mattapan, Mass.
Otway, Alfonso O. (D), 238 Jackson St., Newton Center, Mass.
Peterson, W. L. (C), 55 Haviland St., Wollaston, Mass.
Picardi, Rosario L. (D), 18 Bowman St., Malden, Mass.
Richardson, Wm. V. (D), 176 Everett St., E. Boston, Mass.
Ritchie, Robert W. (C), 28A Vincent St., S. Portland, Me.
Shrocki, Raymond W. (D), 55 Revere St., Boston, Mass.
Silver, Frank E., Jr. (D), 8½ Hobart Ave., Beverly, Mass.
Tosi, Carlos H. (D), 1800 Commonwealth Ave., Brighton, Mass.
Wallace, Elmer (D), 62 Washington Elms, Cambridge, Mass.
Wilson, Percy (D), 61 Bishop Rd., Malden, Mass.

CHATTANOOGA

Brooks, R. E. (C), Combustion Engrg. Co., 1032 W. Main St., Chattanooga, Tenn.

CHICAGO

Beck, Michael (D), 4054 W. Monroe, Chicago, Ill.
Dohrenwend, Clayton O. (B), Armour Research Foundation, 35 W. 33rd St., Chicago, Ill.
Hurst, Edmond C. (D), 2754 Hawthorne Ave., Franklin Park, Ill.
Porter, Delbert D. (D), 3801 Wisconsin Ave., Berwyn, Ill.
Powell, Robert (C), Victor Mfg. & Gasket Co., 5750 W. Roosevelt Rd., Chicago, Ill.

CINCINNATI

Hofmann, George (C), 3524 Myrtle Ave., Covington, Ky.
Runck, Charles G. (D), 5041 Wesley Ave., Cincinnati, Ohio.

CLEVELAND

Bennett, Wm. C., Jr. (B), 4703 W. 150th St., Cleveland, Ohio.
Enyeart, R. A. (B), 801 Caxton Bldg., Cleveland, Ohio.
Fuldauer, R. E. (C), The Midland Paint & Varnish Co., 9115 Reno Ave., Cleveland, Ohio.
Hannan, Donald J. (B), 4021 Smith Ave., Cleveland, Ohio.
Herndon, Cecil C. (C), 5774 Main Ave., Ashtabula, Ohio.
Neurath, Robt. W. (B), 1676 E. 133rd St., E. Cleveland, Ohio.
Rosensteel, Robert R. (D), 2109 E. Prospect Rd., Ashtabula, Ohio.

COLUMBUS

Sherman, C. E., (D), 53 N. Hague Ave., Columbus, Ohio.

DETROIT

Braisted, Leroy W. (C), 1445 Square Lake Rd., Pontiac, Mich.
Budzen, John (C), 5608 Renville St., Detroit, Mich.
Carter, Charles H. (C), 6244 Jos Campau St., Detroit, Mich.
Goll, Arthur W. (C), 7815 Navy Ave., Detroit, Mich.
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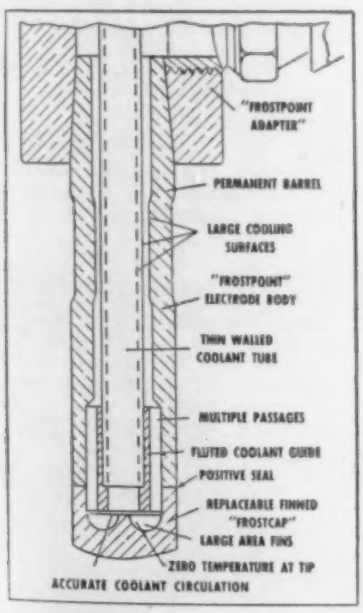

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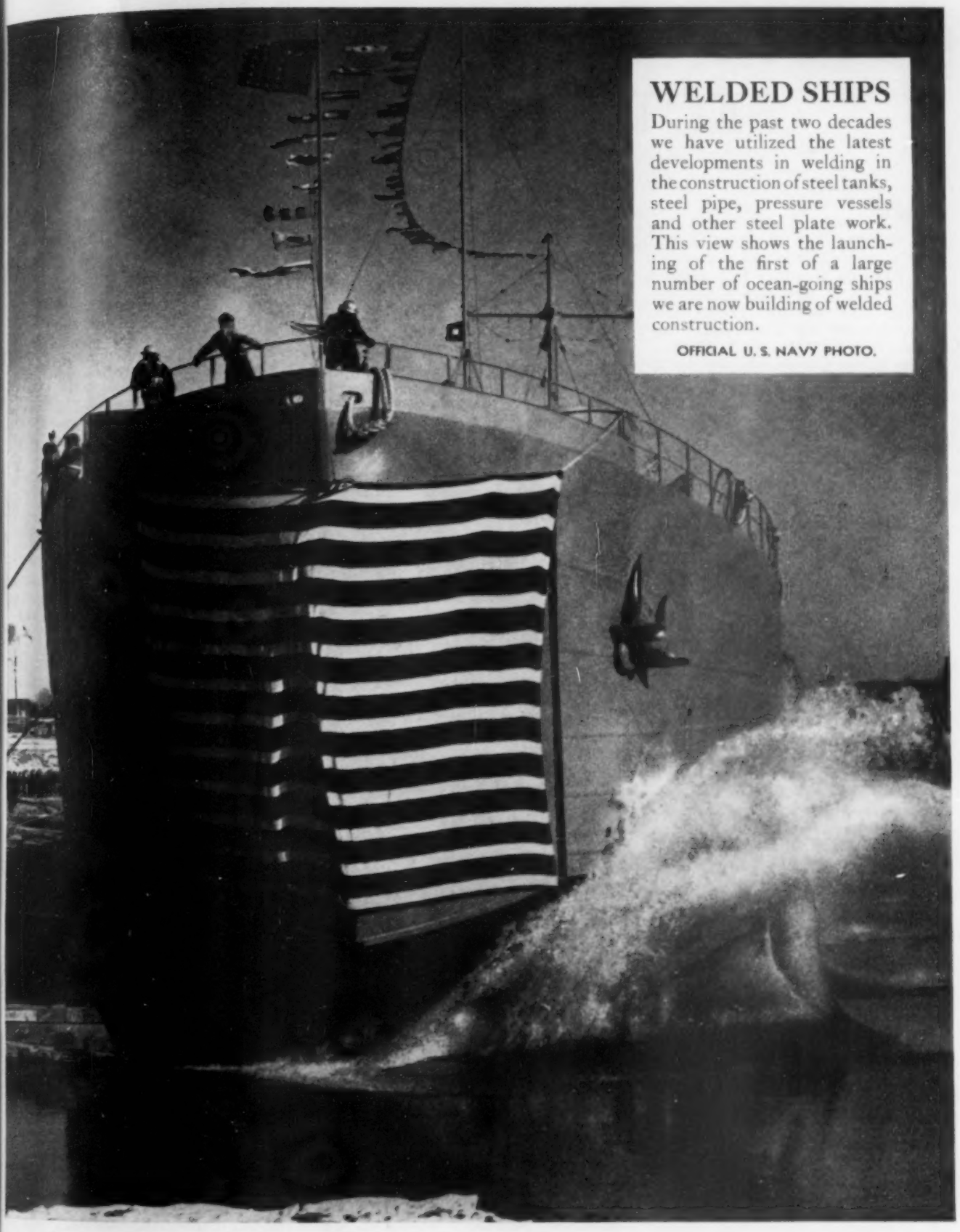

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SECTION ACTIVITIES

BOSTON

At the Annual Meeting held on April 13th, the following officers were elected to serve for the year 1943–44: *Chairman*, F. W. Davis, E. B. Badger & Sons Co., Boston; *Vice-Chairman*, P. E. Kyle, Mass. Institute of Technology, Cambridge; *Secretary-Treasurer*, P. N. Rugg, Boston Edison Co., Boston; *Trustee*, H. G. Austin, Lukenweld, Inc., Boston; *Directors* (2 years), J. B. Donovan, Artisan Metal Products, Inc., Charlestown, W. F. Weissinger, Pullman Standard Mfg. Co., Worcester, and E. H. Swim, B. F. Sturtevant Co., Hyde Park.

When the meeting adjourned, Frank H. Conant, Photographer and Lecturer, and Director of Photographic Department, Mass. Institute of Technology, gave an illustrative talk on "Fishing for Fun," using natural color films with music and sound effects.

CHATTANOOGA

The Chattanooga Section of the AMERICAN WELDING SOCIETY held their regular April meeting Thursday evening, April 22nd, at Hotel Patten.

Prior to the regular address given by Mr. G. S. Mikhalapov, there was a dinner meeting, and Mr. A. R. Mumford in the Research Department of Combustion Engineering Company in New York gave a short talk on boilers.

Mr. Mikhalapov's address was "New Developments in Resistance Welding and How to Use Them." His talk was very instructive and educational.

There was a very nice turnout for both the dinner and the regular meeting.

CINCINNATI

Mr. H. W. Foege of Eutectic Welding Alloys, Inc., spoke on "Low-Temperature Welding and Brazing" at the May 10th meeting of the Cincinnati Section.

CLEVELAND

A welding conference designed to assist all war industries, as well as any users of welding processes, to gain full advantage from welding was held in Cleveland May 14th for the benefit of industry throughout northeastern Ohio. Speakers included outstanding welding authorities and nearly 500 men attended.

The sole reason for the conference was to inform welding users on latest techniques and procedures of welding processes which will speed up weld production and, therefore, shorten the time required to produce essential parts for tanks, ships, planes and guns.

The program included subjects which are of importance not only to plants engaged in actual war production but any others who employ the process in general manufacturing construction or equipment maintenance work.

Colonel Scott B. Ritchie, Chief of the Service Branch of the Chief of Ordnance Office, Washington, D. C., reviewed the important contributions of welding processes in production of mechanized war vehicles in a talk entitled, "Welded Weapons of War." Colonel Ritchie is a graduate of West Point 1917 and was an artillery officer overseas in the last War. He became an ordnance officer in 1921 and has been in charge of research and development in many different capacities since that time.

Significant contributions of welding in the production of destroyer escort vessels and sub-chasers were reviewed by W. E. Whitehouse, assistant to the president, Defoe Shipbuilding Co., of Bay City, Mich. This yard, one of the nation's leading producers of this type of vessel, owes its outstanding production record to efficient application of welding in ship construction. This yard employs a unique method of ship construction in which the hulls of the 300-ft. vessels are welded upside down. This facilitates welding and permits fastest possible production speed. Welding has made it possible for the nation's shipyards to produce five vessels per day.

Two other authorities who addressed the conference were G. S. Mikhalapov, War Metallurgy Committee of National Research Council, and Robert E. Kinkead, widely known welding consulting engineer.

Sponsored by the Cleveland Section, the conference was held at Hotel Statler with an afternoon session at 2 o'clock, evening session at 8 o'clock and a dinner at 6:30 was addressed by Dr. E. E. Dreese of Ohio State University, on the subject, "Welding World of Tomorrow." Dr. Dreese forecast the influence of welding on future designs of automobiles, planes, buildings, ships and bridges.

COLUMBUS

Mr. B. L. Wise, Asst. Manager, Federal Welder and Machine Co., was the speaker at the May 14th meeting. Mr. Wise spoke on "Resistance Welding in War Effort."

DETROIT

Past-Chairmen and Ladies Night was held by the Detroit Section on May 7th in the beautiful Rackham Memorial Bldg. Because of food restrictions and shortage of help, the usual dinner-dance was not held. The meeting opened with the showing of the General Electric television film. The Section was privileged in having Mr. Malcolm W. Bingay of *The Detroit Free Press*, one of Detroit's most interesting and popular after-dinner speakers, who gave a stirring and inspiring talk on our duty as American Citizens.

This was the last Section meeting to be held until the fall season starts. The meeting closed with the showing of the English film "Target for Tonight." There were about 250 people present.

The following officers and executive committee have been elected by the Section: *Chairman*, Earl H. Foss, Murray Body Corp.; *Vice-Chairman*, Henry C. Neitzel, Whitehead & Kales Co.; *Second Vice-Chairman*, George J. Friebel, Harnischfeger Corp.; *Secretary-Treasurer*, G. N. Sieger, S-M-S Corp.; and, *Executive Committee*, E. G. Biederman, C. H. Buckmaster, L. W. Clark, Frank Coates, H. C. Cogan, D. H. Corey, E. O. Courtemanche, G. J. Dekker, J. M. Diebold, V. S. Fegley, T. E. Galligan, J. E. Graham, A. J. Last, A. H. Lewis, C. E. Phillips, G. H. Schliecker, M. R. Scott, Keither Sheren, G. W. Sloan, Otis L. Smith, W. R. Stickney and Thornton Urquhart.

KANSAS CITY

The last regular meeting of this Section was held Tuesday evening, May 4th.

Reviewing briefly the accomplishments of the last year, Mr. Wm. S. Farr gracefully bowed himself out as Chairman, handing over the gavel to the newly elected Chairman, Mr. Edgar H. Finlay, after he had announced the officers for the year, as follows: *Chairman*, Edgar H. Finaly; *Vice-Chairman*, E. D. Anderson, *Secy.-Treas.*, Duane De Brunner.

The Section feels that Mr. Farr has done an excellent job in a difficult time. He has deserved and has had the cooperation not only of the local members but of his department assistants. All programs under the direction of Mr. E. D. Anderson have been interesting and effective. More than a score of new members have joined this year under the energetic efforts of Mr. Ed Cellwork.

Mr. Jim Hall, Plate Engineer of the Kansas City Structural Steel Co., gave the group an interesting slide lecture on the fabrication of jigs used in building landing barges. This lecture was interesting and informative and showed how the combination of knowledge with common sense can originate ingenious devices which will do a job easier and better.

LOS ANGELES

The last meeting of the Los Angeles Section was held April 15th, at which

time the Section had the honor of hearing Dr. Donald Clark, Professor of Metallurgy at the California Institute of Technology. Because of Dr. Clark's popularity and his authoritative analyses in the metallurgy of welding, there was a record attendance of 185.

Interesting motion pictures also enlightened the meeting. The Section through the cooperation of the British Consulate had been able to obtain some very interesting 16-mm. sound films covering the various war activities.

On April 30th the Section participated in a War Production Clinic. This clinic as a whole was sponsored by the N. E. M. A., but there were nine panels which held a separate discussion after the general meeting and the local Section of the AMERICAN WELDING SOCIETY sponsored the welding panel. The speakers who presented various phases of the possibilities of increased production through welding were the following: Francis Stevenson, *Chairman;* Bill Roberts, Keynote Speaker; Charles Johnson, Shipbuilding Industry; Walter Thomas, Welding Jop Shop; Francis Stevenson, Aircraft Welding; J. O. Rosenblatt, Resistance Welding.

MARYLAND

The March meeting held at the Engineers' Club had for subject matter "Practical Aspects of Fusion Welding," which was carried on as a general discussion after a 5-min. talk by selected men on the following subjects coming under the general headings: "When Is Stress Relieving Necessary?"; "Influence of Electrode Size on Quality of Weld"; "Uphill vs. Downhill Vertical Welding"; "Single Pass vs. Multiple Pass Welds"; "A.-C. Welding as Compared to D.-C. Welding."

As each subject was handled by well-qualified local men an instructive and interesting meeting resulted.

The May meeting was covered by Mr. Van Rennsselaer P. Saxe, Consulting Engineer, who spoke on "Structural Welding" illustrated by slides showing detail as well as general application of welding as used in building frames.

MILWAUKEE

The regular monthly meeting of the Milwaukee Section was held on April 21st as a joint meeting with the Engineers' Society of Milwaukee. An after-dinner talk was given by Capt. Robert G. Polhamus, Public Relations Officer, 26th Transport Group, Air Transport Command, Army Air Base, General Mitchell Field.

The welding address on "Atomic Hydrogen Welding" was given by L. G. Pickhaver, Field Engineer, General Electric Company, who discussed the fundamentals of this process and covered its various applications to present day welding requirements.

NEW YORK

The annual meeting of the New York Section was held on Tuesday, May 11th, at the Engineering Societies Building.

At the business session preceding the regular technical meeting, the following officers and members of the Executive Committee were elected for the 1943–44 Season:

Chairman, G. Schneider, Acetylene Welding & Equipment Co.; *First Vice-Chairman,* G. V. Slottman, Air Reduction Sales Co.; *Second Vice-Chairman,* H. W. Northcutt, Bethlehem Steel Co., Shipbuilding Division; *Secretary-Treasurer,* George Sykes, The Linde Air Products Co. *Members-at-Large:* E. Von Steeg, Jr., General Electric Co.; H. R. Morrison, The Linde Air Products Co.; E. B. Stolle, Midwest Piping & Supply Co.; Prof. O. H. Henry, Polytechnic Institute of Brooklyn.

Chairman for the technical session was R. E. Bedworth, Westinghouse Electric and Manufacturing Co., New York. The speaker for the evening was A. M. Setapen, Industrial Engineering Division, Handy and Harman, New York, who spoke on the subject, "Silver Alloy Brazing Goes to War." In his address, Mr. Setapen covered the fundamentals of joining metals with silver brazing alloys and showed, through the medium of slides, how these brazing alloys are being used by industry in producing all kinds of war equipment.

After Mr. Setapen's talk there was a half-hour entertainment period followed by refreshments.

The evening opened with the regular half-hour question and answer period conducted by H. R. Morrison of The Linde Air Products Co.

NORTHERN NEW YORK

Mr. L. C. Bibber, Welding Engineer, Carnegie-Illinois Steel Corp., gave a very good illustrated lecture on "Design for Welding" at the March 25th meeting of this Section.

On April 22nd, Dr. W. F. Hess and his staff from Rensselaer Polytechnic Institute brought those present up to date on their researches, giving a preview of what will undoubtedly be published in due course of time.

NORTHWEST

At the sixth annual meeting of the Northwest Section, Friday, May 14th, the following officers and members of the Executive Committee were elected for the ensuing year:

Chairman, John Mikulak, Mechanical Engineer, Electrical Machinery Mfg. Co., Minneapolis; *Vice-Chairman,* C. M. Underwood, Manager, Welding Department, Northern Pump Co., Minneapolis; *Secretary-Treasurer,* Alexis Caswell, Secretary and Business Manager, Manufacturers' Association of Minneapolis, Inc.

Executive Committee: C. E. Comfort, Plant Superintendent, St. Paul Structural Steel Co., St. Paul; Edgar E. Hall, Superintendent, Flour City Welding Co., Minneapolis; M. H. Hendrickson, Sales Engineer, Smith Welding Equipment Corp., Minneapolis; E. L. Hixson, Welding Supervisor, Minneapolis-Moline Power Implement Co.; T. P. Hughes, Asst. Professor, Mechanical Engineering, University of Minnesota; Louis T. Kenny, President, Kenny Boiler & Mfg. Co., St. Paul; R. H. Newton, District Manager, Lincoln Electric Co., Minneapolis; R. W. Robinson, Manager, American Bridge Co., Minneapolis; E. C. Schroeder, Foreman, Paper, Calmenson & Co., St. Paul; R. J. Stoddard, Asst. Chief Engineer, American Hoist & Derrick Co., St. Paul; T. J. Warmington, Plant Manager, Wm. Bros. Boiler & Mfg. Co., Minneapolis; M. M. Weist, District Manager, Air Reduction Sales Co., Minneapolis; J. E. Williams, District Manager, The Linde Air Products Co., Minneapolis.

George C. Jordan, editorial writer for the Minneapolis *Star-Journal,* was the speaker of the evening on "The Mediterranean Situation," and the new sound technicolor motion picture produced for the Tourist Bureau of the State of Minnesota, entitled "Land of Plenty," was also shown.

C. E. Comfort, chairman of the Section, presided. The financial and membership reports of the officers showed a gratifying increase over conditions at the last annual meeting.

PHILADELPHIA

The regular monthly meeting of the Philadelphia Section was held on Monday evening, April 19th, and was addressed by Mr. R. S. Babcock of The Linde Air Products Co. on "Recent Developments in Oxyacetylene Machine Cutting." The extent to which flame cutting and machining have been developed in many lines of war industry was effectively covered and proved to be of great interest to the well-attended meeting.

The results of the election of officers for the 1943–44 season were announced as follows: *Chairman,* H. W. Pierce; *Vice-Chairman,* M. W. Brewster; *Treasurer,* R. D. Thomas; *Secretary,* H. C. Boss; *Executive Committee,* W. F. Carson, T. M. Jackson and W. S. Wagner.

On Friday, April 30th the Section sponsored a panel discussion on "Training of Welders and Women in Welding." The Chairman of the panel was Mr. W. W. Barnes of the Air Reduction Sales Co., assisted by Mr. A. J. Gollnick, Dravo Corp., Mr. W. W. Whitley, New York Shipbuilding Corporation, and Mr. H. E. Illingworth, Mastbaum Vocational School.

PITTSBURGH

The Sixth Annual Tri-State Welding Conference sponsored by the Pittsburgh Section of the AMERICAN WELDING SOCIETY and the Engineers' Society of Western Pennsylvania, was held on Friday, April 30th in the Auditorium of the Mellon Institute of Industrial Research. A Get-Together Dinner was held at the Hotel Webster Hall, at which Mr. J. H. Humberstone, Middle Eastern Division Vice-President, was the dinner speaker.

At the meeting Mr. Norman G. Schreiner, Unionmelt Division Engineer of The Linde Air Products Co., spoke on the subject "Shipbuilding by the Unionmelt Process." This discussion dealt

particularly with reference to the technique and procedure pertaining to shipbuilding, first developed in the Sun Shipbuilding and Dry Dock Co., further developed by the Federal Shipbuilding and Dry Dock Co., supplemented by further procedures developed in the first West Coast shipyards. Both films and slides were used.

ROCHESTER

The semi-annual bowling party of the Rochester Section was held at Ridge Hall on Saturday evening, April 10th. Bowling and cards were enjoyed by an exceptionally large attendance.

The May meeting of the Rochester Section was held on the 6th at Todd Union, University of Rochester. As usual, dinner preceded the meeting. Dr. G. V. Slottman, Manager Applied Engineering, Air Reduction Sales Co., was the speaker at the meeting. Dr. Slottman spoke on "Welding and Cutting in the Shipbuilding Industry."

Newly elected officers for 1943–44 are as follows: *Chairman*, Everett L. Hand; *Vice-Chairman*, Paul A. Ecklund; *Secretary-Treasurer*, Harold J. King; and *Executive Committee*, Walter G. Dick, P. H. Goeltz, Edward G. Habel, Clyde K. Martin and Joseph B. O'Rorke.

SAN FRANCISCO

The March meeting of the San Francisco Section was held at the California Golf Club, Baden, Calif., on Friday, March 26th. There were approximately 150 members and guests in attendance at this dinner meeting.

The following officers were elected for the coming year: *Chairman*, R. O. Waldman, Chicago Steel & Wire Co.; *Vice-Chairman*, C. M. Doggett, Moore Dry Dock Co.; *Secretary*, Richard E. Labagh, Victor Equipment Co.; *Treasurer*, H. W. Saunders, Air Reduction Sales Co.

The meeting was addressed by Mr. O. Overgaard, Naval Architect, Moore Dry Dock Co., who spoke on "Welding Sequence and Procedure as Related to the Building of Ships." All of the members and guests found Mr. Overgaard's remarks very interesting and enlightening.

Mr. Basil A. McLain, of the American Bureau of Shipping, expressed his thoughts on the subject of shipbuilding on the West Coast.

A committee was formed of two members from each of the shipyards in the San Francisco Bay area to investigate and report on the problems and experiences with regard to welding sequence and procedure in the building of ships.

The April meeting was held on the 30th at the Athens Athletic Club, Oakland. Mr. H. E. Kennedy addressed the meeting on the subject of "Measurements of Residual Stresses Set Up During Welding and the Procedure for Relieving Them." A sound motion picture "How to Weld Aluminum" was shown during the latter half of the meeting.

SOUTH TEXAS

The South Texas Section held its regular meeting at the Houston Engineers' Club, Houston, Texas, on April 22nd. Mr. G. H. Sandberg, Engineer for the Wilson Welder and Metals Co., gave a very interesting talk about arc welding in helium atmosphere. After the talk Mr. Sandberg had a very interesting discussion with the group.

WASHINGTON, D. C.

On April 26th the Washington Section had its last meeting until the fall. A good turnout of about 100 members and guests was present for refreshments and dinner. After dinner the officers for next year were introduced and a chapter medal was presented to William E. McKenzie, as retiring chairman, by A. G. Bissell. A very excellent talk on welding electrodes was given by Dr. J. Miller, Metallurgist of The Reid Avery Co.

The newly elected officers are as follows: *Chairman*, H. L. Ingram; *Vice-Chairman*, W. B. Bunn; *Treasurer*, R. P. Wood; *Secretary*, B. J. Brugge; *Executive Committee*, L. H. Faucett, A. G. Bissell, W. H. McKenzie, A. Amirikian, A. W. Lubbers, C. E. Jackson, G. E. Knox, R. B. Swope, R. S. Stover, S. W. Trainer, Tage Beck and J. C. Ritter.

WESTERN MASS.

The Western Mass. Section held a meeting on April 28th in the B. P. O. Elks Home, Holyoke. The meeting was opened at 8 p. m. by the Chairman, Mr. Emery, who welcomed the 71 members and guests in attendance representing 16 companies.

Mr. Emery then called for the minutes of the March meeting and the Executive Committee Meeting of March 13th. The following appointments were announced: Chairman of the Program Committee, H. S. Hill; Chairman of the By-Laws Committee, R. W. Gamache; Chairman of the Membership Committee, Miles I. Stray; and Chairman of the Publicity Committee, H. E. Ballard.

Closing the business meeting, Mr. Emery proceeded to the introduction of the technical speaker for the evening, Dr. W. G. Theisinger, Welding Engineer with the Lukens Steel Corp.

Dr. Theisinger presented a talk on steel plate production, illustrated by slides and technicolor movies called "The World's Largest Plate Mill." Subjects covered by the talk were, the casting of billets, rolling, cropping, descaling, trimming and finishing of steel plate. Dr. Theisinger also showed some heavy fabrication operations and the metallurgical aspects of welding, heating and stress relief. Dr. Theisinger's talk was highly instructive and met with the approval of the group as expressed by the many congratulations tendered to him at the conclusion.

YOUNGSTOWN

At the Annual Meeting for the election of officers, the following officers were elected for the coming year: *Chairman*, Robert Fischer; *Vice-Chairman*, Arthur Waldo; and *Secretary-Treasurer*, Carl J. Heltzel.

Employment Service Bulletin

SERVICES AVAILABLE

A-451. Welding Expert. Prominent Welding Engineer, consultant, author and educator; Stevens and R. P. I. graduate; seeks position with essential industry, engineering group, or educational institution. To improve existing welding methods; develop new procedures; convert to welded design; supervise production; estimate; set up training programs for engineers and operators.

A-452. Research position wanted by worker in resistance welding. Background of electrical engineering. Advanced study in metallurgy, electronics, and welding. Thesis on spot welding of brass. Six years' shop experience on spot, seam, and projection welding of stainless and low carbon steel. Recent experience on tungsten, molybdenum, nickel and other materials. This experience includes adjustment and care of all kinds and sizes of welding machines and associated electronic control.

A-453. Night Welding Superintendent, 14 years' experience on all types of Arc Welding. Familiar with and have passed A.P.I.-A.S.M.E. and Navy code tests. Have college and T.W.I. certificates on the training and instruction of new men plus two years' instruction and 9 years' supervisory experience. Good reference. Age 35. Available July 12th.

A-454. Thoroughly experienced Welder Operator and Instructor. 18 years' experience, arc and acetylene. 12 years as welding foreman, production welding and shipyard experience. Last 15 months as chief Instructor for vocational training for war production workers, training welders for shipbuilding industry, and other defense plants. Have worked as toolmaker. Prefer place in sales and service. Age 38. Married, two children.

A-455. Welder and Instructor. 15 years' experience in manufacturing and maintenance welding and teaching. Experience includes heavy and light welding, blueprint reading, layout and supervising. Some machine shop. Can teach anything I know. Certified A welder, arc, Army Air Corps. Age 38. Two children. Highest references.

A-456. Several years' experience as a welder and also completed a course in welding engineering in shipbuilding at Drexel Tech. Desires position with an engineering firm or as an assistant to a welding engineer.

A-457. Twelve years' experience in welding. Have been employed in various capacities, engineer, foreman, inspector and instructor. Recently welding engineer in Puerto Rico.

A-458. Experienced Pipe or Tank Welder looking for position on overseas contract. Certified to work on high-pressure piping on Army or Navy work. Several years' experience on pipe welding and high pressure boilers or tanks.

A-459. Experienced Welding Supervisor desires position. References.

BACK NUMBERS OF THE JOURNAL

The AMERICAN WELDING SOCIETY is short of a number of back copies of THE WELDING JOURNAL. These are in demand by workers in defense industries and by libraries.

A list of the issues which the SOCIETY would like to obtain is given below. Any member who has no need for his back copies will be conferring a favor on the SOCIETY if he sends them in. If some reimbursement is desired, the SOCIETY is willing to pay 25¢ per copy sent in.

November 1934

January, February, March and September 1935

January, August, September and October 1936

March, April, May, June, July, August and December 1937

January, February, March, May and November 1938

January 1939

January, February, May, August, and December 1940

January and February 1941

October and November 1942

The SOCIETY would also like to obtain copies of the old 1938 *Welding Handbook* which members are no longer using. Several libraries have made requests for these.

WHICH JOBS FOR YOUNG WORKERS IN WELDING OCCUPATIONS?

The art of Welding is an essential tool of industry, and when efficiently applied has effected savings of both time and material—vital factors in the war effort. Satisfactory welding requires in addition to proper engineering design, that welding operators be trained in the skillful and safe use of welding equipment and that they apply sound welding practices. As the use of welding has increased, so has the demand for trained welding operators.

Thousands of men and women have been trained in welding occupations during the past year. Between August 1, 1942, and February 1, 1943, approximately 270,000 men and women were trained in welding occupations by the public vocational schools in cooperation with the State boards for vocational education and the United States Office of Education under the program of vocational training for war-production workers. Of these men and women 100,000 were employed workers receiving upgrading training; 170,000 were new trainees. For the period July 1, 1942, through January 1943, the National Youth Administration trained 54,000 in welding occupations. Additional thousands were trained by private industry.

Welding used to be considered a man's job, but many of the newly trained welding operators are women and older boys and girls. Owing to the diminishing supply of adults readily available for training, in some places boys and girls of the 16- and 17-year age group are being trained and employed in the welding process. Although the employment of these young persons is usually not necessary or advisable, when they are employed, it is important that they be safeguarded from undue hazard and protected from injury. A leaflet, the sixth of a series of advisory standards on the employment of young workers in war industries, is intended to serve as a guide for the placement of young people in jobs where they are least likely to be injured. U.S. Dept. of Labor, Children's Bureau, Washington, D.C.

WESTERN SOCIETY OFFICERS

Dr. C. Earl Webb, designer of bridge and western division engineer of the American Bridge Company, Chicago, has been elected President of the Western Society of Engineers for the year 1943–44.

WAR PRODUCTION BOARD

WASHINGTON, D. C.

To Manufacturers and Distributors of Compressed Gases

You are aware of the serious shortage of cylinders for compressed gases such as acetylene and oxygen, which will become more acute as the war effort increases and more cylinders are required by the armed services. I am apprised that the manufacturers and distributors of compressed gases have taken the initiative in meeting this problem by adopting various methods to secure more rapid cylinder turnover, whereby more gas can be handled with fewer cylinders. Certain techniques which your industry has employed, such as requiring that empty cylinders be returned when full cylinders are supplied and restricting the time that cylinders may be retained by customers, seem eminently sound.

Compressed gases are a vital part of the war production program and the critical problem of cylinder availability bids fair to become more serious. I would emphasize that the War Production Board fully supports and encourages your action and urges that it be intensified. If the industry's efforts are unable to produce adequate results, the War Production Board is prepared to implement conservation measures by a suitable order.

DONALD NELSON, *Chairman*

THE FUTURE OF THE PRIVATE SCHOOL

Several letters have been addressed to the Editor calling attention to the plight of the small private welding school.

The Government has taken over a number of the larger welding schools substantially subsidizing them for welding operator training during the war emergency.

However in order to focus public attention on the situation we quote below extensively from a typical letter.

"The private school is part of the small business and individual enterprise which someone so wisely said is the backbone of America. The majority of this group are businesses which were established before the war began and are headed by men who are specialists in their field.

"The private schools of which I write have had the responsibility of procuring and selecting possible trainees, working out their problems for them, bringing them back to class when they became discouraged and dropped out, and nursing them along during a training period sufficient for them to qualify for their place among skilled craftsmen. Then there is the responsibility of placing them on a job. In this respect these small schools have made a very good showing, for, during ordinary times the graduate of the private school really had to have "something on the ball" in order to get a chance. Of course some schools gained a good reputation with local employers, which made it a little easier for their graduates to get a chance.

"In the preparatory period before the war, and in the days which followed Pearl Harbor, these schools buckled down to hard work procuring and training students for aircraft factories, shipyards, and other industries important to the defense of our country. In most cases they invested in more shop equipment, office equipment, printing, advertising and established a field force to procure more students. During those hectic days the average private school could not get enough students to train, in order to meet the needs of industry.

"At this point the public educators, with the help of Government funds, established "Defense Schools." Now the time has come, when, due to the draft of the proper eligibles and the uncertain status of all other manpower, there just does not seem to be enough men available to keep both the Defense Schools and the private schools in existence. Of course, the private schools will be the ones to fade out because they have to exist on the tuition paid by their students. Then, too, no business can sell its services when practically the same thing is given "free" across the street, with an unlimited amount of publicity and advertising.

"Many of our private schools have worked long hard years to establish their reputation. Some of them have reinvested all of their earnings in their establishment; but now they have reached the end of their rope. Some of them have already closed; others are trying to hang on because their school and reputation are their life's work and nothing else matters, but even they are dropping off every day. They could be called "just another war casualty." That would be fine if they were non-essential; but they *are* essential. They have recruited and trained more men right to work building ships, tanks, guns, airplanes and factories, than any other source of trained skilled workers.

My suggestion is that they could be taken over by the Government and utilized to great advantage, then turned back to the owners after the war. In this way the Government could make use of their facilities, personnel, and experience, to train *more real qualified skilled workers* at less cost than in any other way, or the schools could be paid a flat rate for every student they procured and trained. I am sure that if the actual cost of procuring and training workers under the present defense training program was computed, and the amount made available to private schools, the Government, industry and everyone concerned would profit by their experience and help during the present emergency, thereby saving another valuable American industry."

Now, *All-Position* A.C. Welding with New Murex Type A Electrode

This new rod has been designed to meet the demand for an electrode that can be used with A.C. current and that will handle easily in the overhead and vertical as well as in the flat and horizontal positions. ¶ The new Murex Type A electrode meets these specifications superbly. It is fast winning friends for welding of high pressure mild steel piping, ships and structural steel work—and for other applications where an all-position electrode is desirable. ¶ According to many tests in laboratory and in the field, deposited weld metal is clean and smooth, without gas pockets or slag inclusions. Fusion and penetration are excellent. ¶ Murex Type A electrodes meet the requirements for Grade E-6011 electrodes under A.W.S.-A.S.T.M. specification A-233-42T; for Grade III, classes 1 and 2 under U.S. Navy Bureau of Ships Specification 46E3; and for Grades H1G, B1G, and E1G, American Bureau of Shipping. ¶ Type A is available in 3/32", 1/8", 5/32" and 3/16" sizes. Typical physical properties of the weld metal, stress-relieved, include yield points of 47,000 p.s.i. to 56,000 lbs. p.s.i., ultimate strengths of 60,000 to 68,000 lbs. p.s.i. and elongations of 27% to 32% in 2".

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TENTATIVE PROGRAM

TWENTY-FOURTH ANNUAL MEETING
AMERICAN WELDING SOCIETY
WEEK OF OCTOBER 18, 1943

HOTEL MORRISON, CHICAGO, ILLINOIS

Make Room Reservations Early—Direct with Hotel Morrison

Arrive Sunday 17th—(Convention Hotel) Rates Apply for Short or Long Stay

IMPORTANT

ALL Technical Sessions will positively start on time.

No Stenotype Reporter—Members desiring to discuss papers are urgently requested to prepare discussion in writing in advance of the meeting and to send copies to headquarters as those preparing written discussion will be given preference at the sessions. Members and guests giving extemporaneous discussion at meeting should forward a written transcript of discussion as soon as possible after the meeting.

Members and guests are urged to REGISTER immediately upon arrival at A.W.S. HEADQUARTERS and obtain Convention Badge admitting them to Exposition.

NO REGISTRATION FEE but a charge of $1.00 (per member) and $1.50 (non-member) is made for Technical Sessions Papers.

Registration hours throughout the week:

Hotel Morrison

Monday, Tuesday and Wednesday 9 A.M. to 5 P.M.
Thursday 9 A.M. to 12 Noon

MONDAY, OCTOBER 18th, Morning—9:30 A.M.

OPENING SESSION

Chairman—K. L. HANSEN,
President, American Welding Society

Vice-Chairman—E. V. DAVID,
Chairman, Convention Committee

PRESENTATION OF MEDALS AND PRIZES

The Adams Lecture, by Dr. C. A. ADAMS, First President, American Welding Society

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Monday Afternoon—2:00 P.M.

SIMULTANEOUS TECHNICAL SESSIONS

CUTTING

Chairman—ELLSWORTH L. MILLS,
Bastian-Blessing Co.
Vice-Chairman—H. E. ROCKEFELLER,
The Linde Air Products Co.

Flame Cutting Heavy Steel Sections of Large Diameter
by R. L. DEILY and C. BENYO, Bethlehem Steel Company

Welding and Cutting in Steel Mills
by T. W. MORGAN, American Rolling Mill Co.

Electronic Control of Gas-Cutting Machines
by R. D. McCOMB, General Electric Co.

Machine Cutting for Assembly Line Fabrication
by CHARLES O. ADAMS, Delco Products

RAILROAD

Chairman—A. G. OEHLER,
Editor, Railway Age
Vice-Chairman—C. E. MORGAN,
Chicago, Milwaukee & St. Paul R. R.

The Welded Locomotive Boiler
by E. G. YOUNG, University of Illinois

Welding as It Applies to Railroads
by ROBERT MORAN, Missouri Pacific R.R.

Railroad Shop Welding and Cutting
by J. W. KENEFIC, Air Reduction Sales Co.

Welding of Railroad Transport Equipment
by C. DREUTZLER, Electro-Motive Corp.

WELDABILITY

Chairman—A. B. KINZEL,
Union Carbide & Carbon Res. Labs.
Vice-Chairman—C. H. JENNINGS,
Westinghouse Elec. & Mfg. Co.

Investigations at Lehigh
by GILBERT E. DOAN, Lehigh University

Investigations at Rensselaer Polytechnic Institute
by WENDELL F. HESS, R. P. I.

The Weldability of Silicon Steels
by C. E. JACKSON and G. G. LUTHER, Naval Res. Lab.

Weld Bead Hardness Tests on Plain Carbon, Nickel and Nickel-Chromium Steels
by OSCAR E. HARDER and C. B. VOLDRICH, Battelle Memorial Institute

Monday Evening—7:30 P.M.

MOTION PICTURE FILMS

Chairman—E. R. SEABLOOM, Crane Company

Vice-Chairman—R. E. McFARLAND, Western Electric Co.

General Electric Film on Atomic Hydrogen Welding

An Address on Welding in Ordnance Construction, by COL. S. B. RITCHIE, Chief of the Service Branch of the Chief of the Ordnance Office.

TUESDAY, OCTOBER 19th, Morning—9:30 A.M.

SIMULTANEOUS TECHNICAL SESSIONS

RESISTANCE WELDING

Chairman—JOHN D. GORDON, Detroit Electronic Laboratory
Vice-Chairman—C. L. PFEIFFER, Western Electric Co.

Flash Welding of Alloy Steels
by C. M. MANZER, General Electric Co.

The Spotwelding of Carbon and Alloy Steels Particularly in Heavy Gauges
by JOHN BARRETT, Taylor-Winfield Corp.

The Spot Welding of the Carbon Steels SAE 1020, SAE 1035 and SAE 1045 in the 0.040-In. Thickness
by WENDELL F. HESS, Rensselaer Polytechnic Institute

TUBING

Chairman—J. P. DODS, Summerill Tubing Co.
Vice-Chairman—H. S. CARD, Formed Steel Tube Institute

Welded Steel Tubing—Quality Control and Application
by R. D. MALM, Clayton Mark & Co.

Machine Welded Metal Tubing
by G. C. GRIDLEY, Mechanics Universal Joint Div., Borg-Warner Corp.

Oxyacetylene Tube Welding
by A. C. WEBER, Laclede Steel Co.

FLAME HARDENING AND HARD FACING

Chairman—D. H. COREY, The Detroit Edison Co.
Vice-Chairman—R. G. HAWLEY, Link Belt Ordnance Co.

Ordnance Flame Hardening
by S. SMITH and J. G. McILHINEY, Air Reduction Sales Co.

Proven Applications of Flame Hardening
by EDWARD GRUBER, Wheeling Steel Corp.

Hard Facing of Punches and Dies for Hot Forge Shells
by J. A. GALLAHER, Haynes Stellite Co.

SHIPS

Chairman—DAVID ARNOTT American Bureau of Shipping
Vice-Chairman—F. M. SCOTTEN, Great Lakes Engineering Works

Welding in Ship Construction
by DON LEACH and EDWARD WALTERS, Chicago Bridge & Iron Co., Shipbuilding Div.

Welding in Ship Construction
by PAUL ARMSTRONG, Mississippi Valley Structural Steel Co.

Welding in Ship Construction
by R. W. BRENDLE, Tampa Shipbuilding Co.

Tuesday Afternoon—2:00 P.M.

SIMULTANEOUS TECHNICAL SESSIONS

RESISTANCE WELDING

Chairman—R. E. POWELL, Western Electric Co.
Vice-Chairman—B. L. WISE, Federal Machine and Welder Co.

Why the Weld Recorder
by J. R. FETCHER and J. VAN DEN BEEMT, E. G. Budd Mfg. Co.

Double Pressure Systems as Applied to Resistance Welding Machines
by S. M. HUMPHREY, Taylor-Winfield Corp.

Stored Energy Welding of Mild Steel
by J. M. DIEBOLD, General Motors Truck and Coach

Flash Welding of Nickel and High Nickel Alloys
by W. F. HESS and A. MULLER, Rensselaer Polytechnic Institute

SHIPS

Chairman—JAMES C. BLAKE, Commander, USNR, Bureau of Ships
Vice-Chairman—H. W. PIERCE, New York Shipbuilding Corp.

Planning for Production Welding and Cutting in Modern Shipyards
by J. G. MAGRATH, Air Reduction Sales Co.

Thermit Welding and the Maritime Commission Work
by J. H. DEPPELER, Metal and Thermit Corp.

Quality of Steel Delivered to Our Shipyards
by R. B. LINCOLN, Pittsburgh Testing Lab.

Longitudinal Welded Joints
by A. G. BISSELL, Bureau of Ships, Navy Dept.

RESEARCH

Chairman—H. C. BOARDMAN, Chicago Bridge & Iron Co.
Vice-Chairman—T. S. FULLER, General Electric Co.

Fatigue Strength of Fillet Welded Joints
by W. M. WILSON, University of Illinois

The Hammer Test for Welded Pressure Vessels: An Investigation
by C. O. DOHRENWEND, Armour Research Foundation

Investigation of a Normalizing Procedure to Improve the Grain Structure of Welds in Carbon-Molybdenum Pipe
by I. A. ROHRIG, Metallurgist, Research Dept., and D. H. COREY, Welding Engineer, The Detroit Edison Company

Correlation of Structure and Strength of Spot Welds in Aluminum Alloys
by DANA SMITH and F. KELLER, Aluminum Company of America

Evening—7:30 P.M.

University Research Conference—H. C. BOARDMAN, Chairman, Presiding

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WEDNESDAY, OCTOBER 20th, Morning—9:30 A.M.
SIMULTANEOUS TECHNICAL SESSIONS

AIRCRAFT

Chairman—G. N. SIEGER, S-M-S Corporation
Vice-Chairman—J. R. DAWSON, Union Carbide & Carbon Res. Labs.

Fatigue Strength of Welded Aircraft Joints
by T. V. BUCKWALTER, The Timken Roller Bearing Co.

The Spotweldability of Low Carbon and Other Aircraft Steels
by L. C. BIBBER and JULIUS HEUSCHKEL, Carnegie-Illinois Steel Corp.

Weldability Tests of Aircraft Structural Steels
by S. L. HOYT and C. B. VOLDRICH, Battelle Memorial Institute

NON-FERROUS WELDING AND BRAZING

Chairman—R. L. KOHLBRY, Machinery and Welder Corp.
Vice-Chairman—E. E. ISGREN, R. G. LeTourneau, Inc.

Modern Methods for Welding Copper and Its Alloys
by J. J. VREELAND, Chase Brass and Copper Co.

Carbon Arc Welding of Naval Brass
by KENNETH L. WALKER, Foster Wheeler Corp.

Aluminum Brazing Sheet—Fundamentals of Metal Flow
by M. A. MILLER, Aluminum Research Laboratories

PIPING

Chairman—F. C. FANTZ, Midwest Piping and Supply Co.
Vice-Chairman—F. C. FYKE, Standard Oil Development Co.

Oxyacetylene Distribution Systems
by D. F. GUTHRIE and R. W. STEWART, Air Reduction Sales Co.

Large Welded Pipe Lines
by L. G. CHRISTOFFERSON, Chicago Bridge & Iron Co.

Weldability of 27% Chrome Steel Pipe
by R. A. MUELLER, I. H. CARLSON and E. R. SEABLOOM, Crane Co.

Wednesday Afternoon—2:00 P.M.
SIMULTANEOUS TECHNICAL SESSIONS

AIRCRAFT

Chairman—G. S. MIKHALAPOV, War Metallurgy Committee, National Research Council
Vice-Chairman—R. T. GILLETTE, General Electric Co.

The Heliarc Welding of Magnesium Alloys as Used in Airplane Fabrication and Substitution for Critical Materials
by T. E. PIPER, Northrop Aircraft, Inc.

Fatigue Studies of Welded Test Triangular Structures with NE8630 Steels
by A. J. WILLIAMSON, Summerill Tubing Co.

Fabrication and Welding of Aircraft Exhaust Tubing - Manifolds and Headers
by C. D. LaFOND, Buhl Stamping Co.

Arc Welding X4130 Aircraft Tubing
by W. T. TIFFIN, University of Oklahoma

INSPECTION, QUALIFICATION AND TRAINING

Chairman—O. B. J. FRASER, International Nickel Co.
Vice-Chairman—L. M. SKIDMORE, General Motors Institute

Symposium on Applicable Methods of Inspection of Arc Welding for
(1) **Shipbuilding**—J. LYELL WILSON
(2) **Structural**—R. B. LINCOLN
(3) **Pressure Vessels and Piping**—W. D. HALSEY
(4) **Aircraft**—J. B. JOHNSON
(5) **Machinery**—N. L. MOCHEL

General Problems of Training Welding Operators
by A. N. KUGLER, Air Reduction Sales Co.

REPAIR AND MAINTENANCE

Chairman—L. S. McPHEE, Whiting Corp.
Vice-Chairman—E. C. BRECKELBAUM, Harnischfeger Corp.

Bronze Welding in the Design and Maintenance of Forming Dies
by C. E. SWIFT, Ampco Metal, Inc.

The Job Shop—Past, Present and Future
by F. W. SHACKLETON, Central Ohio Welding Co.

Maintenance of Tools and Equipment
by T. B. JEFFERSON, The Welding Engineer

Tool Reclaiming by Brazing and Welding
by W. A. JOHNSON, International Harvester Co.

Evening—7:30 P.M.

Section Officers Dinner and Conference

THURSDAY, OCTOBER 21st, Morning—9:30 A.M.
SIMULTANEOUS TECHNICAL SESSIONS

AIRCRAFT

Chairman—P. H. MERRIMAN, Glenn L. Martin Co.
Vice-Chairman—H. O. KLINKE, Republic Aviation Corp.

Quality Control of Aircraft Spot Welding
by NATHAN C. CLARK, Lockheed Aircraft Research Lab.

The Application of Flash Welding in Airplane Construction
by C. B. SMITH, Douglas Airplane Co.

Spot Weld Joint Efficiency for Aluminum Alloys
by C. W. STEWARD, Curtiss-Wright Corp.

Spot Welding of Magnesium Alloys
by H. W. SCHMIDT, Aircraft Welding Research Committee WRC.

PRODUCTION

Chairman—A. M. CANDY, Hollup Corp.
Vice-Chairman—OTIS L. SMITH, Weldit Acetylene Co.

Automatic Arc Welding Solves Production Problems
by R. F. WYER, General Electric Co.

Transition from Riveted to Welded Construction of Light Tanks
by WM. OSHA and J. W. SHEFFER, American Car and Foundry Co.

Welding of Armored Tanks
by WILLIAM BOESE, Pullman Standard Car Mfg. Co.

PRESSURE VESSELS

Chairman—ISAAC HARTER, Babcock & Wilcox Co.
Vice-Chairman—W. E. CRAWFORD, A. O. Smith Corp.

Adaptation of War Emergency Code Materials to Welded Pressure Vessels
by E. R. FISH, Hartford Steam Boiler Insp. & Ins. Co.

Welding of Dissimilar Metals
by DR. W. A. PEARL, Whiting Corp.

Thursday Afternoon—2:00 P.M.

Business Meeting

3:00 P.M.

Board of Directors Meeting

SOCIETY HEADQUARTERS—HOTEL MORRISON, CHICAGO

In order not to be disappointed, members of the Society are urged to make reservations promptly by writing to Leonard Hicks, Jr., Morrison Hotel, Chicago. It is imperative that these letters mention the name "American Welding Society Convention."

The rates for single rooms are $3.30, $3.85, $4.40, $5.50. The rates for double rooms are $4.40, $4.95, $5.50, $6.60, $7.70, $8.80. Rooms with twin beds are from $5.50 up. A large number of suites are available ranging in price from $9.90 on up depending upon the number of rooms and space.

Inasmuch as it is believed that the Hotel will be filled, members are requested to indicate their exact stay so that the rooms may be rented to members coming in later.